DOING WHAT YOU THINK VS. DOING WHAT YOU FEEL:
USING AFFECT TO EVALUATE THE QUALITY OF STRUCTURED RISK
MANAGEMENT DECISIONS

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ABSTRACT

Significant attention has been devoted recently to improving the quality of risk management decisions. One of the main thrusts of these efforts has focused on developing and testing structured decision making (SDM) approaches that help decision makers to define their objectives and make the tradeoffs necessary for complex, risk-based decision making. SDM facilitators argue that these approaches have been largely successful at enhancing the quality of the resulting judgments. However, decision quality is an elusive concept, and past studies have often based evaluations of the quality of SDM approaches on the self-reported behavior of decision makers, a largely process-oriented measure of quality. The research reported here was designed to test this basis for decision quality by comparing self-reported behavior of decision makers (process) with actual choice behavior (outcome) across varying affective contexts. The context for this experiment was the management of risks in a hypothetical state nature area. The experimental approach utilized a previously tested decision structuring approach as a means of encouraging informed judgments that reflect the participants' values and objectives. I hypothesized that this approach would lead
participants to make more thoughtful and better informed decisions that accurately reflected their objectives, not based solely on self-reports, but also on internally consistent decision making behavior. The subjects’ self-reports provided support for the hypothesis. However, further analysis of decisions made by individuals in the structured condition revealed a lack of agreement between their self-reported evaluations and actual choice behavior. In most cases, subjects did not make choices that accurately reflected the objectives that they had previous stated as most important. The results of this research demonstrate that relying solely on process quality measures (e.g. self-reports), and not incorporating outcome quality measures (e.g. the ability of participants to make choices that reflect their objectives) may inaccurately portray to ability of structured approaches to actually encourage more informed judgments.
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Public participation is now a part of many decision making processes for managing environmental risks. Calls for participation are based on the assumption that these processes will lead to higher quality management decisions. Higher quality decisions are expected to more accurately reflect the concerns of all stakeholders, and ultimately be more successful at reaching the stated goals due to widespread approval and support for the decision. However, a wealth of research from a variety of fields demonstrates that people are generally poor decision makers, due in large part to the fact that they are unable to fully comprehend the multi-dimensional nature of risk and address the difficult tradeoffs associated with management options (Keeney 1992, Gregory et al. 2001). They also have a tendency to rely heavily on judgmental shortcuts and heuristics, which frequently results in choices that fail to address the full range of decision-relevant concerns (Kahneman et al. 1982, Slovic 2000, Bohnenblust and Slovic 1998). Additionally, findings from behavioral decision theory indicate that decision makers do not have well-formed preferences prior to a decision,
instead, their preferences are constructed during the elicitation process (Payne et al. 1993, Slovic 1995).

In response to these cognitive shortcomings, previous research has focused on ways to structure decision processes to elicit analytically sound and deliberative analysis from non-expert decision makers (Arvai et al. 2001, Arvai et al. 2002, McDaniels et al. 1999). These structured approaches are meant to aid and encourage decision makers to better understand the problem, clarify their objectives, create alternatives that address their objectives, and make the necessary tradeoffs across the alternatives (Hammond et al. 1999). In general, the success of these approaches at increasing overall decision quality have been based on rather vague notions of what constitutes an effective decision making process, the observations of individuals facilitating the process, and self-reports of individuals participating in the process.

Due to the emphasis that structured approaches put on individual values and objectives, measures of structuring quality in experimental contexts tend to rely heavily on individual self-reports. Self-reports may be an appropriate measure of process quality, which is of primary importance; however, self-reports may not be a complete measure of the overall quality or success of the approach. Overall quality is also affected by the outcome or the ability of the participants to make choices that reflect their stated objectives or concerns. This ability is largely
affected by the context of the decision and the ability of decision makers to utilize two fundamental modes of judgment: analysis and affect.

Modern theories in cognitive psychology supported by experimental evidence indicate that an emphasis on analysis and deliberation in decision making may still lead to suboptimum choices because of a lack of balance between two complementary modes of cognitive processing: the "analytic system", which is deliberate, relatively slow, and requires conscious control, and the "experiential system", which is intuitive, mostly automatic, and linked by experience to emotion and affect (Zajonc 1980, Finucane et al. 2000, Peters and Slovic 2000). Affect is a feeling-state that people experience in response to a stimulus, such as "calmness" or "upsetness", or a quality associated with a stimulus such as "goodness" or "badness" (Slovic 2000). These affective judgments are often the first response to a stimulus, therefore guiding future information processing and judgments. In particular, use of the affect heuristic results in judgments that are shaped exclusively by the varying degrees of positive or negative affect associated with the stimuli. This over-reliance on affective feelings contradicts the previously stated findings that analytic or deliberate judgments should operate in parallel with experiential or affective judgments for optimal decision making.

Structured decision making approaches should not only encourage sound analysis and deliberation of information provided by risk communication, but also
account for affective judgments and incorporate these intuitive, emotional judgments into the decision. As mentioned previously, overlooking the role that affect plays in a decision making process may result in biased judgments that do not reflect the true concerns or objectives of the decision maker, resulting in poor decision quality. This study focuses on this much needed area of structured decision making research, namely measures of decision quality. Past quality measures have focused either solely on process or outcome quality, or on self-reported behavior or subjective outside measures of success. It is difficult to produce an overall measure of decision quality that accurately reflects both the quality of the process (e.g. incorporating values and encouraging thoughtful participation) and the success of the outcome (e.g. making choices that reflect the participants values and objectives). Therefore, the objective of this research is to identify a measure of decision quality that links self-reports of process quality with measures of outcome success. The research poses the general question; how effective is a modified structured decision making approach at increasing overall decision quality? More specifically, how effective are these efforts at encouraging analysis and overcoming the tendency of participants to use the affect heuristic when making complex decisions?

The objective of this research was to design a structured decision making approach that aids non-experts to both address tradeoffs and construct more thoughtful preferences that accurately reflect their values (analysis) and balance those often unconscious emotional responses to the risks (affect). An
experiment was designed to evaluate the quality of this structured approach intended to help non-expert decision makers consider multiple objectives, address tradeoffs, and construct more thoughtful preferences about a multiattribute risk management problem. The methods were similar to those applied both practically and experimentally in past studies. However, in order to overcome the measurement challenge, it was necessary to design an experiment where the best course of action could be ascertained based on the stated objectives of the participants. That way the participants’ final choice could be compared to the previously identified standard. This was achieved by manipulating the decision context such that decisions motivated by careful consideration of objectives would yield outcomes that would likely be different from ones motivated primarily by a simplifying heuristic such as an over-reliance upon affect.

This research used affect as a means of creating a more robust decision quality metric to evaluate how people actually make choices. Do their final management choices correspond with their stated values? Specifically, do they decide based on careful analysis of values and tradeoffs (e.g. structured decision making) or do they rely on relatively faster, and in this context, lower quality affective responses? The results provide insight for future risk communication efforts that aim to inform stakeholders’ judgments about environmental risks and associated management alternatives, especially when the context for the decision involves policy or management alternatives that range on an affective scale. The results
also help to address lingering questions about measuring and increasing decision quality, specifically when utilizing structured decision making approaches.
CHAPTER 2

2. RISK COMPREHENSION AND ANALYSIS

Chapter summary: This chapter serves as an overview of risk research by describing “risk” and explaining the need for both analytic (technical) and affective (social) measures of risk. It also explores the concept of risk analysis which consists of risk assessment and characterization (measuring the risk and integrating the technical measures with social concerns), risk management (taking action to alleviate, eliminate, or adapt to a risk), and risk communication (transferring information between experts and non-experts to inform assessment and management).

2.1 What is risk?

Risk is a complex concept that is often measured and evaluated in different ways. The National Research Council (1996) uses the term “risk” to refer to things, forces, or circumstances that pose a threat to people or to something that they value. This definition is open to non-probabilistic interpretations of risk. Ropeik and Gray (2002, p.4) define risk as “the probability that exposure to a hazard will lead to a negative consequence”. These two different definitions of risk demonstrate the complex, dual nature of the concept; that risk is defined by both social and technical measures.
Along these lines, research in cognitive psychology indicates that humans comprehend risk in two basic ways (Epstein 1994, Slovic 2000). These two ways include the "analytic system", and the "experiential system". These two systems have also been referred to as two different ways of knowing; the analytic system associated with intellect and the experiential system associated with feelings and experience (Epstein 1994). The use of these two separate systems or modes is generally evident in human decision making processes, regardless of the role of risk in the decision. For example, humans tend to make decisions and reflect on them as choices made with either the "head" (e.g. intellect), or the "heart" (e.g. emotion). These two systems result in two different measures of risk, namely analytic or technical risk measures and affective measures of risk as a feeling. These two measures will be discussed in the following sections.

2.1.1 Risk as analysis

The analytic system is based on normative rules like probability, logic, and risk assessment. It results in a deliberate, technical assessment of the risk that requires cognitive effort and conscious control (Slovic et al. in press). This technical view of risk (r) can be measured quantitatively based largely on the relationship between the probability (p) that a risk event will occur and the severity of its consequences (c). Therefore, analytic risk is a function of probability and consequences (r=pxc) (Ropeik and Gray 2002). This technical view of risk is one-dimensional, assuming that risks with the same computed r are directly comparable and may be considered equal. For example, traveling
six minutes by canoe and smoking 1.4 cigarettes a day are equally likely to increase your chance of death by one in a million (Wilson 1979). Although these two activities are quantitatively equal in terms of analytic risk (e.g. chance of death), most people would consider traveling six minutes in a canoe to be less risky because of the other non-quantitative factors that play into decisions about risk.

Analytic risk measures include purely statistical calculations (e.g. actuarial), causal assessments (e.g. health and environment), and probabilistic assessments (e.g. safety and engineering). All three types of technical or analytic risk assessments, predict potential harm by averaging an event over time and using the observed or modeled frequency of that event to calculate a probability. Statistical calculations of risk depend on extrapolations of the relative frequency of an event over time. Causal assessments of risk rely largely on identifying and quantifying causal relationships, such as the extent to which a potential risk may result in harm to humans or other organisms. Probabilistic assessments use fault-tree analyses to predict the probability of safety failures in each component of a system in order to model the overall fail rate of the larger system (Renn 1992).

These technical or analytic risk analyses help decision makers to estimate the future consequences of an event or action, but they cannot be used alone to measure risk. Analytic or probabilistic risk measures are not adequate when
used exclusively because they do not account for the perceptions of those impacted by the risk. Perceptions and social constructions of risk must also be included to identify, evaluate, and manage risk. These affective measures of risk are required to broaden the scope of risk comprehension and assessment, and will be discussed in the following section.

2.1.2 Risk as a feeling

The experiential system is the most common method of evaluating risks, because it is automatic, intuitive, and does not require conscious effort. It is based on a comprehension of risk as a feeling, where personal values shape the individual's view of each specific risk (Slovic et al. in press). This system relies on images and associations, linked by experience to the psychological system known as affect. Affect is defined as the specific quality of "goodness" or "badness" that something is perceived to hold. It is experienced as a feeling state, and results from a positive or negative reaction that an individual has to a stimulus (Slovic 2000).

The affective nature of risk is largely defined by individual risk perceptions. Risk perceptions are the judgments that people make when asked to evaluate the level of risk associated with an event or an activity. The most common method or framework for measuring these perceptions is based on the psychometric paradigm (Figure 2.1). It uses psychophysical scaling and multivariate analysis to derive quantitative measures of individual attitudes and perceptions toward
risk (Slovic 1987). The basic finding of this approach is that there is no such thing as “objective” or “real” risk. Rather, risk is socially defined by a wide array of factors. These factors vary from case-to-case, but are typically psychological (e.g., feelings of dread, control, etc.), social (e.g., issues of equity), institutional (e.g., imposed by a third party of voluntary), or cultural (e.g., risk experienced by a minority) in nature (Slovic 1987, Slovic 1992). For example, society cares about more than just minimizing probabilistic risk. Their willingness to accept risk relies on other factors. Some people are willing to suffer harm, or be exposed to risk, if they feel it is justified or serves a greater goal. However, the same people may reject even the smallest risk if they feel it is being imposed upon them (Renn, 1992).

2.1.3 Balancing analysis and affect

The automatic, affect-based side of our judgments is a relatively new area of research that was largely neglected in the past. Psychologists used to believe that feelings, or affective responses, were post-cognitive, that they only came into play after considerable information processing (Zajonc 1980). However, affective judgments are now thought to be an individual’s first reaction during decision making, therefore guiding future processing and judgment (Slovic 2000).

For thoughtful judgments to be made, the analytic and affective systems should work in unison, each depending on the other for guidance (Zajonc 1980, Finucane et al. 2000, Peters and Slovic 2000, Slovic et al. 2002). The problem is
that they do not often operate in this manner. Oftentimes, the individual will unconsciously rely more heavily on one or the other system, resulting in suboptimal decisions or choices that do not address the full range of decision-relevant concerns. For example, Hsee (1998) performed a study where participants were asked to indicate their willingness-to-pay for a small overfilled cup of ice cream (5 oz cup with 7 oz of ice cream), and a large underfilled cup of ice cream (10 oz cup with 8 oz of ice cream). When the two cups were evaluated separately, participants relied solely on affective judgments and placed a higher value on the cup that was overfilled because their only frame of reference for the value of the ice cream was the size of the cup. In reality, the overfilled cup held less ice cream than the larger, underfilled cup. However, there was no way for the participants to realize this because they had no reference point for comparing the absolute value of the ice cream. This study shows how relying solely on affect in decision making, when there is no frame of reference for analysis, results in suboptimal judgments.

Damasio (1994) demonstrated an over reliance on analysis in situations where affective judgments were not available to the individual, resulting in suboptimal judgments. He studied patients with brain damage that left them with the intelligence, attention, memory, and logical abilities thought necessary for rational behavior. However, the damage impaired their ability to “feel”, or to link their emotions with the future consequences of their actions. He found that people suffering from this handicap were capable of analysis and reasoning, but
incapable of rational thought and lacking the ability to make decisions in their best interest.

2.2 Risk analysis

The goal of risk analysis is to increase understanding about a risk and the associated consequences in order to develop comprehensive, viable options for management (NRC 1996). A thorough risk analysis should account for both analytic (probabilities and consequences) and affective measures of risk (values and social factors) (Bohenblust and Slovic 1998).

Specifically, risk analysis consists of risk assessment and characterization (measuring the risk and integrating the technical measures with social or affective dimensions), risk management (taking action to alleviate, eliminate, or adapt to a risk), and risk communication (transferring information between experts and non-experts to inform assessment and management). The relationship between these three components is depicted in Figure 2.2. The National Research Council (1996) suggests using an analytic-deliberative process to structure risk analysis and inform risk decisions. This type of process focuses on continuous analysis and deliberation to ensure the transfer of valid scientific information, as well as allow equal input from all participants. According to the National Research council report,
"Analysis uses rigorous, replicable methods developed by experts to arrive at answers to factual questions. Deliberation uses processes such as discussion, reflection, and persuasion to communicate, raise and collectively consider issues, increase understanding, and arrive at substantive decisions. Deliberation frames analysis and analysis informs deliberation" (1996, p.20).

The analytic-deliberative framework includes the following stages: problem formulation, process design, selecting options and outcomes, information gathering, synthesis, decision, implementation and evaluation. An iterative process of learning and feedback allows the process to be adjusted at any one stage, depending on the specific situation. The degree of participation from public officials, natural and social scientists, and interested and affected parties changes throughout the process. For example, scientists are most active during the problem formulation stage and as deliberation warrants. Public officials have increasing involvement as the process approaches synthesis and implementation. Interested and affected parties are equally involved throughout the process, from problem formulation to the final decision (NRC 1996).

The analytic-deliberative process recognizes that scientific or technical consensus is insufficient for the characterization of a risk, and that anecdotal knowledge must be included during risk analysis. This knowledge can be incorporated through public participation, which is considered a requirement for rational decision making under risk. This process also recognizes that the acceptability of a risk depends on the involved parties being informed of the
consequences of their decision as well as how their decision may reflect their interests and values. Finally, in order to integrate public or social values into a decision, the process requires the input of those people or parties affected by the decision (NRC 1996, Renn 1999).

2.2.1 Risk assessment

The first component of risk analysis is risk assessment. According to the NRC (1996), assessment is the technical, science-based analysis and characterization of the adverse effects of a hazard. This quantitative assessment of risk is largely performed by scientists and technical experts, often producing information that is difficult for the public or non-experts to understand. This gap in understanding is addressed by risk characterization, which is the interface between assessment and management. The goal of risk characterization is to synthesize the information about a potentially hazardous situation by addressing not only the technical aspects of the risk, but also the social, values-based judgments surrounding the risk. The goal of this step of the risk decision process is to address the needs of all interested parties prior to making a management decision through an iterative process of analysis and deliberation (NRC 1996).

2.2.2. Risk management

The second part of risk analysis is risk management. It is the process of identifying various regulatory options and evaluating their attributes to select a management option from among them (NRC 1996). Traditionally, risk
management was left to the experts, resulting in their playing the dual role of assessor and decision maker. This approach to management often resulted in an exclusion of public interests and values during the decision making process (von Winterfeldt 1992). This approach also resulted in a distrust of experts in decision making positions, as well as poor decisions that did not reflect societal concerns.

However, risk management has evolved over the past several decades from a very technical practice, to one in which the public and other stakeholders are partners throughout the process. This evolution is the result of calls for increased public involvement in setting policy for risk management decisions (McDaniels et al. 1999, NRC 1996, Renn 1999, Chess and Purcell 1999). The National Research Council reports that incorporating public values and input from the outset of the decision making process is essential (NRC 1996). According to other research, those involved in risk management decisions must realize that utilizing a combination of technical expertise and public values is necessary for effective risk assessment and management (Gregory and Keeney 1994, Fischhoff 1995, Bohnenblust and Slovic 1998, Renn 1999). Incorporating social values as part of the decision process allows risk managers to develop management solutions that address the concerns of all interested parties and are ultimately more acceptable over the long-term.
Incorporating the public in these decision processes is difficult because of the complexity of the decisions, the technical uncertainties regarding the risks, and the perplexing value tradeoffs that often must be made. Actual instances of successful public involvement are often difficult to find (Slovic 1986). In order to overcome this dilemma, decision analysts have developed methodologies to incorporate both stakeholder values and technical information regarding risk when evaluating management or policy alternatives. The methodologies focus around structuring the decision making process to foster the involvement of citizens in risk management, and effectively incorporate social values (Gregory 2000, Renn 1999, NRC 1996). A structured approach allows citizens to be informed about risk, which may eliminate any bias or misperceptions. It also allows citizen input to be actively incorporated into the final management decision. These structured decision making approaches for policy and management decisions will be discussed in detail in later sections.

2.2.3 Risk communication

The third part of risk analysis is risk communication. It is defined as any purposeful, interactive exchange of information and opinions with the public regarding a risk and the related concerns or reactions of the affected parties (Covello et al. 1986, NRC 1989, Fischhoff 1995). It can occur through a variety of media, ranging from warning labels, and cautionary signage, to direct person-to-person interaction between officials and concerned stakeholders (Covello et al. 1986, NRC 1989). Risk communication links assessment and management
by providing the framework for analysis and deliberation between public officials, scientists, and other interested and affected parties (NRC 1989, Renn 1999, Slovic 1986).

There are two main types of risk communication: prescriptive and descriptive. Prescriptive risk communication is the analytic-deliberative process for developing a mutual understanding of the risks and benefits among all interested parties. It is an interactive process of information exchange with the ultimate goal to inform policy and management decisions. Descriptive risk communication occurs after a policy has been made, with the goal being to encourage support for the decision and provide a justification for the choices that were just made as a result of prescriptive communication (Arvai 2000). Ultimately, the main objective of any risk communication program is to inform and encourage support for risk management decisions.

As mentioned previously, there is a growing trend toward incorporating non-expert objectives and judgments during risk-based decision making. With this goal in mind, two-way risk communication programs are becoming essential to incorporating non-experts, namely the public, in these decisions (Arvai 2000). Ideally, carefully structured, two-way communication between expert (e.g., scientists and agency personnel) and non-expert (e.g., community residents) stakeholders about environmental risks should contribute to more thoughtful risk
management decisions that are more likely to be met with widespread approval (NRC 1996, Renn 1999, Gregory 2000).

One specific decision making approach that extends to risk communication design is value-focused thinking (Keeney 1992). This approach differs from the typical, technical-based approaches by presenting the decision relevant information in a way that is salient and easier to understand or process. Using values as a basis for communication allows people to access their own areas of expertise when participating in a decision. People often have a difficult time relating to the scientific facts surrounding an issue, so if that is the focus of the communication, many people will be excluded from the process (Keeney 1992). However, in order to understand how best to incorporate non-experts in a decision process, it is necessary to explore work conducted in decision science, namely behavioral decision research and decision analysis.
Figure 2.1: The psychometric paradigm, a mapping of 81 health risks across two factors derived from the interrelationships among 15 risk characteristics (Slovic 1986).
Risk Analysis

Risk Assessment    Deliberation    Risk Communication

Risk Management

Figure 2.2: The Risk Analysis Framework
CHAPTER 3

3. DECISION RESEARCH

Chapter summary: This chapter lays the theoretical framework for the research reported in this thesis. Specifically, it demonstrates the weaknesses in normative behavioral theory and points to descriptive behavioral theory as a more accurate explanation of choice behavior. The chapter then focuses on structured decision making (SDM) approaches and the techniques that have been developed to encourage more informed judgments. The chapter closes with standards for measuring decision quality and identifies ways in which techniques for decision structuring and quality may be further studied and developed.

3.1 Behavioral Decision Research

In order to participate in effective risk analysis, it is important to understand the information needs of individuals and the way that they process information and make decisions. This insight into human decision making processes is the focus of behavioral decision research. In particular, a central aspect of this research focuses on understanding and improving people's ability to contemplate and make choices in an uncertain environment (Keeney and Raiffa 1976). Decision making under risk or uncertainty greatly alters the way that people make their choices, often resulting in behavior that is contrary to traditional, normative models of decision making. The following sections outline traditional normative
theories of decision making, and then offer several descriptive models that provide a better picture of actual choice behavior.

3.1.1 Normative behavioral theory

Research into choice behavior and the concept of utility first began in the early 1700’s. However, it was not until the mid 1900’s that expected utility theory was fully developed and von Neumann and Morgenstern (1947) formulated the six axioms of rational choice under uncertainty. Their Theory of Rational Choice assumes that individuals are rational to the extent that they make choices that are in their best interest. This normative or prescriptive theory is based on six axioms that define how an individual would or should behave if they followed certain requirements of rational decision making in order to optimize or maximize their utility (Plous 1993).

These axioms pose assumptions that are consistently violated by decision makers who are, by the normative definition, more irrational in their decision processes than rational. For example, the normative model of decision making under risk assumes that a rational decision-maker will prefer an option that offers the highest expected return (e.g., utility), regardless of how the options are described or framed (description invariance) or how the judgments are elicited (procedure invariance) (Tversky 1969, Tversky and Kahneman 1981). However, evidence from a wide variety of experiments and field studies clearly show that this principle of invariance (e.g. that preferences should not depend on the
description or framing of the options or the method of elicitation) is systematically violated. Specifically, research shows that the exact opposite often occurs during decision making. Preferences for the options in a set of alternatives often change depending upon how decision problems are framed, options are presented, or preferences are elicited (Slovic 1995). This notion is contrary to the most basic principle of rational choice theory, and casts doubt on the descriptive ability of normative models.

Demonstrating the inconsistency of preferences, Tversky and Kahneman (1981) reported a series of experiments where minor changes in the formulation, or framing of the choice problems, resulted in significant changes in preference for the options. For example, participants were risk averse when options were framed as gains, preferring a sure gain of $240 over a 25% chance to gain $1000 and a 75% chance to gain nothing. However, participants were risk seeking when the options were framed as a loss, preferring the gamble with a 25% chance to lose nothing and a 75% chance to lose $1000 over a sure loss of $750. The authors concluded that individuals often have different preferences depending on the problem frame, but are unable to resolve these preference inconsistencies when faced with competing frames. Gregory et al. (1993) found that altering the reference point for a decision can alter people's preferences. They found that presenting an environmental improvement as a restoration of a loss garnered greater support than presenting the same improvement as a gain from the current state. Lichtenstein and Slovic (1971) found that buying and
selling prices for gambles were determined by the payoffs, but preferences or the attractiveness of the gamble were determined by the probability of winning or losing. When asked to make choices about a pair of gambles, participants in their studies indicated a higher preference for one option, but placed a higher dollar value on the other option. All of these examples support prospect theory, a descriptive model that attributes the failures of invariance to the different weights that people assign to outcomes depending on whether they are located in the region of gains or the region of losses. In prospect theory, the value of an outcome is expressed as a deviation (gain or loss) from a neutral reference point. The value of each gain or loss can be plotted on an S-shaped value function, with the curve being steeper in the loss region making it more costly to return to the neutral origin and resulting in losses being felt more sharply than equivalent gains (Tversky and Kahneman 1981).

The decision behavior described above is important to consider when communicating with both experts and non-experts about risk. Framing (how the decision problem is presented), information presentation (how the information about the problem is formatted or structured), and response mode (how the decision maker is asked to respond) may affect individual preferences for management alternatives or policy options. These variables can determine how salient the information is to the participants, or what frame of reference they adopt when evaluating the information. Payne et al. (1992) illustrated that people are unable to recognize the role these outside influences have on their choices.
They consistently employed different choice or judgment strategies in response to these variables, but were largely unaware of the effect that this behavior had on their choices.

3.1.2 Descriptive behavioral theory

These inconsistencies and shortcomings led researchers to seek better explanations of choice behavior that more accurately reflected how people actually make choices than the traditional normative theories. These explanations come from descriptive behavioral theory, which attempts to describe beliefs and values and the manner in which individuals actually incorporate them into their decisions (Slovic et al. 1977). Descriptive theory does not just compare actual and normative behavior, but attempts to explain the psychological foundations of observed behavior.

Contrary to the normative theory of rational choice, descriptive theory claims that humans are actually "boundedly rational". This theory proposes that optimal decision making strategies are seldom available and humans are unable to solve problems precisely, so they find techniques to solve problems approximately (Simon 1990). This may result in different solutions to problems depending on what method or approach is currently available or being utilized. For example, one of the most common methods for decision making under bounded rationality is called satisficing. Under this method, decision makers choose the first option that meets their most important needs, and then quit looking for a better solution.
even though a more optimal option may exist (Plous 1993). Another decision making strategy that is often employed is the use of heuristics, or mental short-cuts. They are employed subconsciously when making difficult tradeoffs or selecting among several alternatives. Heuristics are often accurate and beneficial, because they save the decision maker time and help them navigate through life on a daily basis. However, they may also result in a bias, especially in situations where the decision is complex or risky.

Three of the most common heuristics are representativeness, availability, and anchoring and adjustment. Representativeness is the tendency of decision makers to judge the probability of an outcome by using similarity or resemblance. For example, if the characteristics that someone possesses are deemed representative of a specific occupation, then the probability that the person is engaged in that particular occupation is judged to be high (Tversky and Kahneman 1974). Availability results in events that are more salient, or easily brought to mind, having more impact on our judgments. For example, most people would rate the probability of death by a shark attack as higher than the probability of death from a falling airplane part, because of the media attention that fatal shark attacks receive. However, the chance of death from a falling airplane part is actually 30 times higher than death by shark attack (Plous 1993). Anchoring and adjustment is the process by which people make estimates by starting at some initial value and adjusting upward or downward to come up with their final answer. These anchors can be completely irrelevant to the decision,
often resulting in insufficient judgments. For example, participants in one study were given an arbitrary number between 1 and 100 and then asked to provide a median estimate of the number of African countries in the United Nations. The median estimate for participants receiving the arbitrary number 10 was 25, and those receiving the number 65 provided a median estimate of 45 (Tversky and Kahneman 1974).

The affect heuristic is another example of a powerful heuristic that is often used in decision making under risk. It describes a mode of judgment where images, marked by positive or negative tags, guide judgment and decision making (Slovic et al. 2002). Basically, objects and events are tagged in people's minds with varying degrees of affect, positive or negative. When making judgments, people consult this "affect pool" which contains a specific tag for each individual stimulus. These affective cues then shape their judgments (Finucane et al. 2000, Slovic 2000). Decision makers may ignore important attributes or viable options when making judgments if they do not have an affective frame of reference for evaluating those alternatives or options, which may explain the tendency to satisfice as described earlier. Our ability to use information during judgment and decision making is largely dependent on the affective meaning of the information (Slovic et al. 2002).

Descriptive research provides insight into why humans are such poor decision makers, and why they are unable to conform to the notions of rational choice.
For example, researchers have demonstrated that decision makers have difficulty structuring decisions, making tradeoffs, and clarifying objectives. In regards to structuring a decision, Simon (1990) illustrated that the limits of the human brain force people to use approximate methods to handle complex tasks or decisions. He stated that when a task or decision is highly structured (e.g. a step-by-step framework already exists to encourage thoughtful deliberation of the problem, objectives, values, and tradeoffs during the decision process), people use powerful, systematic heuristics to guide them to the goal or solution. However, when the task is not already structured, people find it much more difficult to provide a structure themselves in order to reach the solution. They tend to use weaker heuristics or methods that eventually identify one alternative as dominant, whether or not it is the ideal solution.

In regards to making tradeoffs, Bohnenblust and Slovic (1998) described a decision supporting framework aimed at incorporating both technical analysis and public values in order to encourage more informed policy decisions. They claim that a framework such as the one they present is needed because people lack the tools for defining their full range of concerns, or for understanding what is required when asked to make complex technical tradeoffs common to risk and resource management decisions. As a result, people often select management alternatives that only partially address the full range of concerns because they fail to understand tradeoffs involving conflicting dimensions of value.
In regards to clarifying objectives, March (1978) stated that human decision makers not only violate prescriptive or normative theories of choice, but they actually manage, construct, confound, and suppress their preferences. He claims that humans “deliberately specify our objectives in vague terms to develop an understanding of what we might like to become” (March 1978, p.596). This unwillingness or inability to clarify objectives leads to inconsistent preferences and allows us to adjust our behavior as new preferences are constructed.

3.1.3 Preference construction

One of the most important findings of descriptive research is the idea that preferences are actually constructed during the elicitation process (Slovic et al. 1990, Slovic 1995, Payne et al. 1992). Basically, individuals do not have stable preferences that they retrieve from memory when making decisions; rather they use a variety of methods or heuristics for identifying their preferences when they are elicited. The constructive nature of preference often results in a failure of invariance because preferences can easily reverse or change depending on the context or the method used to arrive at a decision. As demonstrated earlier, this does not support the expected utility model which assumes that a rational decision maker’s choices or preferences will remain constant (Slovic et al. 1990, Slovic 1995, Tversky et al. 1988, Tversky 1969).

Preference construction can be viewed as either a negative or positive decision behavior. The negative implications are that the individual decision maker’s
inability to hold strong, consistent preferences for an option makes them susceptible to suboptimal choices, especially in situations where the decision is complex. Their preferences can even be manipulated by people with a specific agenda or objective. However, the constructive nature of preference can also be an advantage when working with people on complex, risk-based decisions. It gives facilitators or those in charge of a decision the ability to structure the decision process and foster more thoughtful, higher quality decisions. Researchers have developed many different techniques for structuring a decision to encourage informed judgments and these techniques will be discussed throughout the remainder of the chapter.

3.2 Structured decision making (SDM) approaches

Structured decision making (SDM) approaches work to decompose decision problems into cognitively manageable parts and provide decision makers with a series of tasks aimed at encouraging the consideration of multiple objectives as well as facilitating tradeoffs when these objectives conflict. They provide the necessary link between analysis and deliberation, or assessment and dialogue, when incorporating the public in policy or management decisions (Gregory and Keeney 2002, NRC 1996). The goal of these approaches is to combine technical expertise, rational decision making, and public values and preferences into the decision process (Renn 1999).
There are five basic steps to a structured decision process (Hammond et al. 1999, Gregory et al. 2001, Gregory et al. 2000).

- Characterize what matters to the participants and the decision.
- Create a set of alternatives.
- Employ the best available technical information to characterize the possible impacts of the alternatives.
- Identify and discuss tradeoffs based on the values and objectives of the participants.
- Summarize the areas of agreement and disagreement in order to choose the option that best meets the needs and objectives of the group.

Structured approaches are basically a framework for risk analysis. They incorporate techniques from both risk assessment and communication in order to inform the final policy or management decision. Risk assessment techniques are used to incorporate both technical and social information and characterize the risks or possible impacts of the alternatives available for the decision. Risk communication techniques are used to transfer this information between all of the parties involved in the decision, and to identify their objectives and values in order to make tradeoffs and arrive at a final decision. The remainder of this section will outline the various approaches and techniques used in structured decision making.

3.2.1 Decision Analysis

Decision analysis is a formal, prescriptive approach to structured decision making that depends largely on the findings of descriptive behavioral research. Kleindorfer et al. (1993) state that sound prescription must begin with good
In other words, it is first necessary to understand how people form their judgments in order to then encourage and elicit informed judgments. As demonstrated earlier, decision makers are largely inconsistent when making judgments, and unable to deal with complex decision problems. Therefore, the goal of decision analysis, and other structured approaches, is to encourage the decomposition of a complex decision problem into a series of cognitively more manageable judgments (Keeney 1992, vonWinterfeldt and Edwards 1986, Clemen 1986). Without this structure, the average decision maker will rely on heuristics and other simplifying strategies when making complex decisions, often resulting in suboptimal choices (Payne et al. 1992).

Specifically, decision analysis revolves around the development and use of quantitative models like Multi-Attribute Utility Theory (MAUT). This model is helpful for facilitating complex decisions with multiple value dimensions or attributes to evaluate. It actually requires that decision makers compute a weighted utility function for each attribute of each option of choice (Keeney and Raiffa 1976, Clemen 1986). For example, if you are thinking about moving into a new office, there are several different factors to consider, including access for clients, conditions for staff, suitability of space, and administrative convenience. These four factors can then be broken down again into more specific attributes. Client access might be broken down into closeness to client’s homes and access to public transportation. Once you have broken down the attributes, you provide weights for each attribute level, multiply the weights, and add them up. You go
through this process for each possible alternative, and the alternative with the highest utility should represent the option that best meets your needs (von Winterfeldt and Edwards 1986).

3.2.2 Value-Focused Thinking

Value-focused thinking is another type of structured decision making approach which requires that values be incorporated into the decision process along with the technical information regarding the problem or risk. Keeney (1992) defines values as principles that should be used when evaluating an action, alternative, or decision. They denote what is important to the participants in a decision by incorporating their affective or emotional responses. According to many studies, values should be the driving force behind any decision (Gregory 2000, Keeney 1992).

Simply put, value-focused thinking is an approach that first involves deciding what is important to the decision maker and then finding a way to meet those objectives. Using a values-focused approach clarifies the underlying reasons for why an option or alternative is favored or opposed. This prevents the decision maker from jumping too quickly to a choice among alternatives. The more common, alternative-focused approaches not only result in choosing options too quickly from an available set of alternatives, but they do not often result in the best choice (Keeney 1992).
3.2.3 Decision aiding

Decision aiding techniques are another type of structured approach that attempt to prescribe a course of action for decision making that conforms most closely to the decision maker’s actual beliefs and values (Slovic et al. 1977). These more informal techniques are meant to help overcome the cognitive shortcomings that are inherent in human decision making, to encourage informed decisions, and provide insight about policy. There are several different approaches used in decision aiding, but all are centered on the same basic goals. Those goals are to break the decision problem into a series of smaller problems, incorporate value-based judgments into the decision, and encourage tradeoffs across the various attributes.

One common decision aiding technique is PrOACT, an acronym based on five key decision elements, reminding decision makers to be proactive about making smarter choices. These five elements, listed below, constitute the foundation of a structured approach to thinking about a decision problem (Hammond et al. 1999).

- **Problem** – Carefully define the problem
- **Objectives** – Clarify the objectives
- **Alternatives** – Create imaginative alternatives
- **Consequences** – Identify the consequences of each alternative
- **Tradeoffs** – Make tradeoffs across the objectives

The first step is to carefully define the problem. The way that the problem is stated or defined, frames the decision and determines the alternatives that will be
considered and the way that they will be evaluated. If the problem is not correctly defined up front, then the entire process will be based on the wrong decision problem, resulting in a final choice that is suboptimal.

The second step is to be specific about what you want to accomplish by thinking through and clarifying your objectives, which will later become your decision criteria. This step involves clarifying both means and ends objectives. Ends objectives help identify what you are trying to achieve with the decision, while means objectives highlight potential alternatives by clarifying what is fundamentally most important. Discovering what is really most important will identify the basis for evaluating different alternatives and identifying which option best suits your needs.

The third step is to create imaginative alternatives. You should not stop considering new alternatives even when you begin to evaluate the current set. It is important to take the time to consider all of the possible courses of action because you can never choose an alternative that you have not considered, and the chosen alternative can only be the best of the available lot. The best way to identify alternatives is to set high aspirations and challenge the constraints that might seem to exist within the decision.

The fourth step is to identify and clearly lay out the consequences of each possible alternative. This step allows you to see how well each alternative meets
your stated objectives. Carefully describing the consequences increases your understanding not only of the alternatives, but also of the objectives and the problem itself. The greater your understanding of the problem, the better your final choice will be.

Finally, it is almost always necessary to make tradeoffs across conflicting objectives in order to identify the best alternative. It is unlikely that one alternative will perfectly meet all of the stated objectives so it becomes necessary to identify the one that best meets the most important objectives. Reaching the final decision may require that some objectives be discarded (e.g. if the objective is uninformative when comparing the alternatives), or at the very least what seemed to be the most important objective (e.g. cost) might have to be compromised in favor of another objective that now seems more important to the decision (e.g. location).

In decisions that are complex with high levels of uncertainty it is sometimes necessary to consider three more steps during the decision process. These steps are identifying uncertainty within the decision, accounting for individual risk tolerance, and considering how the current decision may affect future decisions (Hammond et al. 1999).
3.2.4 Case studies

There are many examples of structured approaches being used in actual policy and management decisions. The quality and success of each approach depends on the intentions and goals of the participants at the outset. However, the following examples can all be considered successful based on their ability to fulfill one or more of the goals of a structured approach. Some of the examples followed structuring models step-by-step, while others incorporated specific components of structured approaches depending on what was necessary for the decision. The important components that must be addressed in order to be considered a structured approach are identifying objectives and creating alternatives based on multiple stakeholder values, as well as facilitating tradeoffs across various attributes and alternatives.

3.2.4.1 Tillamook Bay watershed

The U.S. Environmental Protection Agency and the National Estuary Program utilized a structured approach for incorporating the public in a study of clean up and protection alternatives for the Tillamook Bay watershed. The goal of the project was to develop a “science-based, community-supported management plan for the watershed” (Gregory 2000, p.37). The one-year process was designed around the decision aiding approach (PrOACT) discussed earlier, and was successful at incorporating both qualitative (values-based) and quantitative (science-based) information into the evaluation of various management and policy options.
3.2.4.2 The Sabah Maliau Basin

A technique for obtaining stakeholder values in order to use them as a basis for creating better policy options was utilized in East Malaysia to evaluate the impacts of a proposed mine site in the Sabah Maliau Basin (Gregory and Keeney 1994). The general approach required that stakeholders, analysts, and decision makers' work together to set the decision context, identify the objectives, and create alternatives that meet the objectives. The main goal was to obtain better objectives by incorporating values, and then to use those clearly stated objectives to develop better policy alternatives. A three-day workshop resulted in the development and consideration of six policy alternatives based on expressed stakeholder values, as opposed to only two alternatives that the participants had originally considered. The workshop also included key interested parties which ensured that a wide range of values were addressed, and it encouraged open communication among the participants which may serve as a foundation for future resource management decisions.

3.2.4.3 The Alouette River Stakeholder Involvement Process

McDaniels et al. (1999) also found that using a structured decision process to clearly address objectives, alternatives, and tradeoffs, led to more effective recommendations for highly controversial water management issues in British Columbia. Similar to the previous examples, the authors used a combination of value-focused thinking and structured decision aiding techniques to guide group decision making. They deemed the effort successful based on the ability of the
diverse group of stakeholders to reach agreement and recommend a highly
effective management alternative. More importantly, they believed that success
was also defined by choosing the right decision framework and accurately
following the steps of that process in order to reach a decision. They believed
that their effort was also successful in reaching that goal.

3.2.4.4 The Cabinet-Yaak Ecosystem

Finally, Maguire and Servheen (1992) give an example of decision analysis
techniques being used in combination with expert consensus to design a
program that would encourage the recovery of brown bear populations in
northwestern Montana, but also minimize human-wildlife conflict in the area.
They discovered that the objectives of maximizing population growth and
minimizing human conflict could not both be met directly, but tradeoff analysis
revealed that the minimum threshold for retention and the maximum threshold for
conflict could be met by reintroducing 4- to 8-year-old females to the ecosystem.
The benefits of the process were many, but most important, it allowed a complex
problem to be dissected into manageable components, and it incorporated both
the technical facts surrounding bear translocations and the biological and
sociological values into the decision.

3.2.5 Beyond Case Studies

There are also many examples of structured approaches being tested
experimentally. The goal of this research has been to test various structured
approaches and gauge their success at incorporating the public in complex technical decisions. However, the definitions of quality and success are often inconsistent and highly varied. In these examples, the quality of the structuring and the decision process is often based on self-reports of participants’ satisfaction, comfort, and ability to address what is most important to them. However, the success of the process is usually defined differently depending on who is conducting the research and again, the intent of the process.

Arvai et al. (2001) presented a small-group experiment where a structured, value-focused decision approach was used to incorporate public stakeholders along with experts in a risk management decision. This specific approach utilized value-focused thinking to link analysis with deliberation, and analytical techniques from multiattribute utility theory to structure the decision. The experimental study had to do with policy decisions for riverine salmon management in British Columbia. The authors found that the structured, value-focused risk communication approach led to more thoughtful, better informed decisions by participants because it helped them consider a wider array of decision-relevant issues and trade-offs (Arvai et al. 2001). They argued that these decision-aiding approaches were beneficial because they helped clarify areas of agreement and disagreement, instead of focusing solely on gaining consensus. The authors believe that structured approaches challenge the current thinking, which is that consensus and dispute resolution result in successful public participation. They think that focusing on consensus and
avoiding conflict results in a tendency to overlook values and prevent public insight from being made available to the decision makers (Gregory et al. 2001).

In another study, Arvai et al. (2002) explored the ability of a structured participatory approach to lead to policy alternatives that were actually seen as more legitimate, or more acceptable to a wider audience. One of the key benefits of a structured approach is the belief that it leads to more widely accepted policy and management decisions. In this experiment, the authors found that when the National Aeronautics and Space Administration (NASA) missions were presented as the product of a structured, participatory decision process, it garnered more support than when the same missions were presented as the product of careful discussion among space agency and technical experts. This experiment supported the notion that it is not just the outcome that is important. People are more likely to support or accept decisions that result from processes that allow the public to express their values and concerns.

Another experimental approach by Arvai and Gregory (2003) compared two alternative approaches for involving non-experts in complex, technical decisions about the radiation cleanup at contaminated sites. Their approaches differed in the way that information was presented to the participants in the study. Although the information in both conditions was factual and scientific, one used a more common, technical communication approach and the other a value-based approach originating from the decision-aiding literature. They found that both
approaches resulted in an increase in knowledge among the participants about the problem, but the participants in the value-based approach felt that the information was more useful for making choices about what really mattered to them. Participants in the value-based approach also appeared to rely less on affective responses when allocating funds to the various sites, and their participation was deemed more meaningful because they were able to access their own areas of expertise during the decision process.

3.3 Decision Quality

The examples given above of structured approaches, both in practice and in research demonstrate that structuring might be useful for encouraging more thoughtful, better informed judgments during risk-based decision making. However, there is little agreement on another important point. How do we define the success or measure the quality of these structured approaches? This is an important question because structured approaches are only useful if they are actually capable of improving the decision process. The question then becomes, how do we measure decision quality?

In the previous examples, the success or quality of the structured process was measured in several different ways. Decision quality seems to be defined differently depending on the goals of the individual process. Matheson and Matheson (1998) propose that there are six dimensions that must each be considered to measure overall quality. They claim that the decision is only as
strong as the weakest link in the decision chain, but they give no suggestions for measuring each dimension. These six dimensions of quality are as follows:

- That the process encouraged the selection of the appropriate frame.
- That the process resulted in creative, realistic alternatives.
- That the process was based on meaningful, reliable information.
- That the values and tradeoffs were made clear.
- That the participants engaged in logically correct reasoning.
- That the process resulted in a commitment to action.

In the previous case study examples, it appeared that all six dimensions were considered to various degrees when evaluating the success or quality of each approach. Some were considered explicitly while others seem to be more implicit in the judgment of quality. The standard for decision quality in structured approaches appears to depend heavily on the fourth dimension, which is that values and the need in most cases for tradeoffs are made clear. It appears that the other dimensions are often assumed to be met, but the only dimension that is clearly evaluated is the ability of participants to identify their values and make the necessary tradeoffs.

Chess and Purcell (1999) in a review of public participation efforts demonstrate that, in general, the quality of the participatory approach is judged by both process and outcome success. Those who judge successful participation solely by the outcome believe that the results determine whether the means by which the decision was made were successful. Those who judge successful participation solely by process believe that the characteristics of the means determine the overall success of the participation effort (Chess and Purcell
1999). The authors also describe a middle ground approach where participatory success is judged by some combination of process and outcome criteria. They are also quick to point out that satisfaction with the process does not automatically mean that participants will be satisfied with the outcome, and vice versa. Process and outcome are often independent and it may be necessary to evaluate both when determining overall decision quality. The six dimensions by Matheson and Matheson (1998) described earlier seem to account for dimensions of both process (e.g. logically correct reasoning) and outcome (e.g. creative, realistic alternatives) success.

Frisch and Jones (1993) argued that decision quality is best measured by accuracy. They defined an accurate decision as “one in which there is a one-to-one correspondence between the factors that affect a decision and those that affect experience” (Frisch and Jones, 1993, p.115). They stated that decision accuracy cannot be assessed through traditional means because there is no objective measure or criterion that we can use to compare to people’s actual choices or decisions. So, we must rely on comparisons of decision preference (e.g. the actual choice) and experience preference (e.g. the choice that is more favorable when experienced). The goal of this approach is to focus not just on the decision, and the ability of people to be internally consistent, but on the way that people experience the outcome.
One measure of quality that appears to be missing in structured approaches is internal consistency. It has already been demonstrated that preferences are inconsistent and actually constructed during the process of elicitation. Is it possible then that choices made during a structured approach may not be consistent? Might participants in a structured decision process claim something one moment, but make a choice that reflects something entirely different the next? Currently, the success of a given approach seems to be measured by self-reports of participant satisfaction, or outside evaluations of the ability of participants to make informed judgments and participate meaningfully in the process. Outcome success often appears to be measured by the ability of participants to come up with creative alternatives and identify an option that effectively meets the objectives. Although these measures are all important, there may be a need to link measures of process and outcome success, to make sure that participants are not only participating meaningfully, but that their final choices reflect their values and the tradeoffs that they claimed to be making.

3.4 Improving measures of decision quality: Providing context for the current research

An area of much needed focus for structured decision making research is in the measures of decision quality. As demonstrated earlier, there are no standards for measuring the quality of a structured process, or the success of the process at encouraging informed judgments. Past quality measures have focused either solely on process or outcome quality, or on self-reported behavior or subjective
outside measures of success. It has proven difficult to combine the two to produce an overall measure of decision quality that accurately reflects both the quality of the process (e.g. incorporating values and encouraging thoughtful participation) and the success of the outcome (e.g. making choices that reflect the participants values and objectives). Therefore, a measure of decision quality that links self-reports of process quality with measures of outcome success would provide researchers and practitioners with a better understanding of the ability of a structured approach to encourage more informed, value-based judgments in complex risk situations.
4. DOING WHAT YOU THINK VS. DOING WHAT YOU FEEL: EVALUATING THE QUALITY OF STRUCTURED RISK MANAGEMENT DECISIONS

Chapter summary: This chapter outlines the experimental approach designed to compare self-reported behavior with actual choice behavior across varying affective contexts as a measure of decision quality. The chapter then reports and discusses the results of the study. The chapter closes with the implications of the findings for future use of structured decision making approaches as a means to improving decision quality.

4.1 Introduction

Significant attention has been devoted recently to improving the quality of risk management decisions. One of the main thrusts of these efforts has focused on developing and testing structured decision making (SDM) approaches. These approaches are based in large part on two important classes of findings from behavioral decision research: First that individuals and groups are seldom able to define their full range of objectives and concerns (Keeney 1992) in the context of risks and, therefore, have difficulty making the necessary tradeoffs when asked to make risk management decisions (Gregory et al. 2001). To combat these problems, decision makers tend to rely heavily on a variety of judgmental
shortcuts (e.g., see Kahneman et al. 1982, Slovic 2000) that work to simplify these choices but frequently lead to the selection of management alternatives that seldom address a full range of decision-relevant concerns (Bohnenblust and Slovic 1998).

The second class of findings that inform the development of structured decision making approaches relate to the constructive nature of preferences (Payne et al. 1993, Slovic 1995). Findings from studies in this context have demonstrated that decision makers seldom have well-formed preferences about risk management options in advance of making judgments and instead “construct” them during the elicitation process. While clearly problematic given the ad hoc nature of many choices, this constructionist view of preferences also has advantages. Chief among them is that it becomes possible to structure elicitation processes that help to encourage more thoughtful analysis. These structured approaches for decision making typically do two things: They decompose problems into more cognitively manageable parts and provide decision-makers with a suite of tools aimed at helping them to construct more thoughtful preferences. At their core, these tools, based on decision analysis, are designed to help decision makers to better understand the context of a given management problem, identify and organize management objectives, create and analyze alternatives with respect to their predicted outcomes, and make tradeoffs across these alternatives when objectives conflict (Hammond et al. 1999).
Given the positive responses of decision makers who have used these approaches and the endorsements of a variety of researchers and practitioners, the frequency with which SDM approaches are used is growing rapidly. A short list of SDM applications, for example, includes their use for helping to prioritize risks (Florig et al. 2001), develop a national energy policy (Keeney et al. 1990), set guidelines for water use by hydroelectric utilities (McDaniels et al. 1999), create estuarine management plans (Gregory and Wellman 2001), and devise strategies for the protection of endangered species (Maguire and Servheen 1992). In each of these cases, SDM facilitators argued that the use of a structured approach helped to enhance the quality of the resulting judgments.

Decision quality is an elusive concept, however. Given the multiattribute nature of risk management, it is difficult—if not impossible—to identify ideal courses of action beforehand and then compare decision maker’s final choices against this benchmark. As a result, evaluations of quality relating to structured decision approaches have been based on rather vague notions of what constitutes effective decision making process (e.g., having the “right” people use the “right” information), the observations of SDM facilitators, and the self-reports of individual decision makers engaged in these processes. In a recent experiment, for example, Arvai et al. (2001) hypothesized that such an approach would help subjects to more fully consider their objectives and concerns, and address tradeoffs thereby leading to more thoughtful decisions and higher overall decision quality. This hypothesis was tested primarily by analyzing data collected in the
form of individual decision makers' self-reports of their comfort and satisfaction with their decisions, as well as the degree to which they felt their final choices addressed their values and concerns. This focus on self-reports is understandable given the emphasis that SDM approaches place on individual's values and objectives and the resulting difficulties associated with identifying the single "best" decision in this context.

This reliance on self-reports ought not to imply that other measures of decision quality aren't desired for evaluating SDM approaches. Many—including myself—agree with von Winterfeldt and Edwards (1986) that the quality of decisions depends solely on the quality of the processes by which they are made. Very much along these lines, McDaniels et al. (1999) proposed that evaluations of decision quality ought to be dependent on the ability of the participants to understand and utilize the tools that make up the SDM process, complete each step of the decision framework, and choose options that address their relevant objectives and concerns. Even these more robust definitions of decision quality, however, pose a potentially significant measurement challenge for evaluations that look beyond decision makers' self-reports or relatively simple qualitative observations. It is this challenge that I wish to address here.

The experiment described herein was designed to evaluate the quality of a structured decision approach intended to help non-expert decision makers to consider multiple objectives, address tradeoffs, and construct more thoughtful
preferences about a multiattribute risk management problem. The approach tested here was similar to methods applied practically (e.g., McDaniels et al. 1999) and virtually identical to ones that have been the focus of recent experiments (e.g., Arvai et al. 2001, Arvai and Gregory 2003). Overcoming the measurement challenge noted above required designing an experiment where, for each individual decision maker, it would be possible to ascertain the best course of action based on their stated objectives; the ultimate choices made by these individuals could be compared with this standard. This requirement was addressed by manipulating the context of a hypothetical (but realistic) risk management problem such that decisions motivated by a careful consideration of objectives would, for most, yield outcomes that were different from ones motivated primarily by simplifying heuristics such as an over-reliance upon affect.

In this context, affect is defined as a feeling-state that people experience such as “calmness” or “upsetness” or a quality associated with a stimulus such as its “goodness” or “badness.” These experienced feelings or qualities, in turn, influence judgments (Zajonc 1980, Rottenstreich and Hsee 2001), sometimes working in parallel with cognitive processes and sometimes pre-empting them. Recent research demonstrates that affective feelings help to guide many risk judgments and decisions (Lerner and Keltner 2001, Loewenstein et al. 2001). In particular, use of an affect heuristic leads to judgments about objects, activities,
and other stimuli shaped by the varying degrees of positive- or negative feelings attached to them (Finucane et al. 2000, Peters and Slovic 2000, Slovic 2000)\(^1\). By choosing risk management problems with a varying affective range (e.g. from affect-poor to affect-rich), it becomes possible to compare subject's self-reports (e.g., "I made a choice that strongly reflected my objectives and concerns") with their actual choice behavior (e.g., decisions that indeed reflected stated objectives vs. ones that were made based on the affective characteristics of the problem context). In other words, the quality of structured risk management decisions can be linked to the degree to which decision maker's final management choices match either their stated objectives (i.e., higher quality choices as defined by McDaniels et al. 1999) or relatively faster but likely lower quality affect-based responses.

4.2 Methods

4.2.1 Context

The context for this experiment was the management of risks in a hypothetical state nature area. Specifically, subjects were asked to provide input for decisions about how state funds should be spent to address three emerging problems. These problems ranged from being affect-poor to affect-rich and included, in ascending order, walking trails in disrepair, white-tailed deer

\(^1\) While I acknowledge the important role that affect and the associated heuristic plays in helping to simplify certain choices such as those with low demands for accuracy (Payne et al. 1993) or more complex choices that must be made under time-pressure (Slovic et al. 2002), complex environmental management decisions of the type often addressed by risk managers ought to reflect more effortful, deliberative modes of judgment.
overpopulation, and wildlife disease. A manipulation check\(^2\) confirmed the level of affect across two dimensions—valence and arousal—for each of the three problems (Table 4.1). All subjects were provided with detailed information describing each of the three problems and were then asked to provide input as to how park managers ought to allocate $500,000 to help address them (e.g., subjects were told that these monies could be used to repair trails, address the deer overpopulation, etc.).

4.2.2 Design

The experiment used an extensively pre-tested\(^3\) workbook prepared in two versions: the unstructured technical (UT) and the structured values (SV) condition, both consisting of 10 pages. The workbook was designed to both inform subjects about the three risk management problems and to obtain judgments from subjects regarding their risk management preferences. The workbooks were completed individually under the supervision of trained facilitators (myself and a research assistant) and, on average, took approximately 30 minutes to complete.

The experiment involved two components with one independent variable (the unstructured or structured condition) and several dependent variables (Figure

\(^2\) Subjects provided ratings across both dimensions on a seven-point scale. Ratings of valence were provided on a scale from very good to very bad (using "neutral" as a midpoint). Ratings of arousal were provided on a scale from very calm to very upset (with "neutral" again a midpoint). These dimensions were then combined to create an overall affect-score for each of the three risks.

\(^3\) I pre-tested workbooks by recruiting students and faculty at The Ohio State University to complete the workbooks and provide feedback on the design and ease of completion.
4.1. Component 1 of the experiment was designed to allow for between-treatment comparisons of self-reports as the main measure of the quality of the decision making process (mimicking past research in this context). As with previous research, the specific dependent variables used for judging the quality of the process included participant’s self-ratings of (i) changes in their level of knowledge, (ii) the degree to which they were able to understand and prioritize issue-specific concerns, and (iii) their level of comfort and satisfaction with their choices. Component 2 of the experiment was designed to allow a within-treatment—in the SV condition only—analysis of the relationship between subjects’ stated objectives and the actual choices (in terms of funding allocations; see below) they made as another measure of the quality of the decision making process. The goal of the study was to identify the degree to which self-reported evaluations matched subjects’ choice behavior.

Both the UT and SV conditions shared four common elements (Figure 4.1). These elements were, 1) background information about the park and its three risk management problems, 2) more detailed information presented in text and in tabular format about the human (e.g. injuries, illness, fatalities) and environmental health (e.g. disruption to wildlife and vegetation, wildlife fatalities, vegetative dieback) risks associated with them, 3) a series of pre- and post-test closed-ended self-rating questions, and 4) a funding allocation (choice) task.
As with previous research in this context, the basic information presented to subjects was the same, but the way in which it was framed differed between the UT and SV conditions. The information in the UT condition was more detailed from a technical standpoint, addressing only the risks to human and environmental health associated with each of the three management problems. This information included the number of injuries (broken down by fractures, sprains, and minor injuries), illnesses (West Nile Virus, Lyme Disease, and Chronic Wasting Disease), and deaths per year, as well as the level of wildlife (mammals, birds, and aquatic organisms) and vegetation (native trees and shrubs, and decorative plants) disruption per square mile (Table 4.2). The goal of such an approach is to improve the available knowledge base so that participants can make choices that are informed by detailed scientific data. This approach is similar in intent to many of the science-based initiatives in decision making now being undertaken by the EPA (EPA 2000).

In the SV condition, information as it related to the three risks was linked to these same technical dimensions, but also explicitly to societal values and to personal objectives for risk management (Table 4.3). This approach is modeled on several decision-aiding initiatives that emphasize value-focused techniques (Keeney 1992, McDaniels et al. 1999, Arvai et al. 2001). Human health risks were described in terms of the general severity of anticipated effects (i.e., using scales from 1 [low severity] to 10 [high severity]) and were not subdivided by the type of ailment, as was the case in the UT condition. Environmental risks were also
presented using 10-point scales that addressed anticipated changes in the levels of wildlife and flora. Subjects also received information about the risks posed by the three problems—again on 1 to 10 scales—to two values-oriented concerns: recreational opportunities (specifically to hiking and camping, wildlife viewing, and hunting opportunities), and the overall aesthetic appearance of the state nature area.

Both the UT and SV conditions began by asking subjects to answer (using closed-ended, 7-point Likert scales) a series of initial self-rating questions. These questions addressed subjects' base level of knowledge about the three risk problems (where 1=very low; 7=very high), understanding of their objectives as they relate to risk management in this hypothetical context (where 1=very poor; 7=very good), and degree of comfort with providing input during the risk management process (where 1=very low; 7=very high). Subjects in both conditions were then presented with the risk information described earlier. It was at this point that the SV and UT conditions differed.

In the UT condition, subjects were asked to consider all of the information that had been presented and then allocate funds (totaling $500,000) across the three management problems. In the SV condition, a series of decision structuring tasks were introduced: Subjects in this condition were first told to rank the four risk-specific concerns (human health, environmental health, recreational opportunities, and aesthetics) from most to least in need of addressing (i.e., their
objectives for this problem). Subjects were then asked to link these ranks with the specific problems described in the workbook. In other words, subjects were asked to translate their stated objectives into management priorities based on the information provided. Finally, subjects were asked to allocate funds (totaling $500,000) such that their choices reflected their previously stated concerns and priorities. For example, assume that a subject ranked human health effects as the greatest concern followed by recreation impacts, environmental health, and aesthetics. In order to make choices that reflected these objectives, this subject then ought to assign the highest management priority—and their largest funding allocation—to wildlife disease, followed by damaged trails and deer over population (by linking impacts across their ranked objectives with the appropriate management problem; Table 4.3).

Both the UT and SV conditions then ended as they began, with a series of closed-ended self-rating questions where responses were provided on 7-point Likert scales. The questions included the five first asked at the start of the experiment as well as two others: the degree to which subjects felt their allocation choices addressed their stated (or ranked) objectives and their overall level of satisfaction with their decisions.

4.3 Data Analysis

Analyses were carried out on the data obtained from the subject's completed workbooks. Subject's responses to the closed-ended self-rating questions were
compared using 1- and 2-tailed 2-sample t-tests for between-condition comparisons, and 2-tailed paired t-tests for within-condition comparisons. Graphical techniques were used to compare means and standard error for affect ratings, ranked concerns, management priorities, and funding allocations. Within-condition comparisons of funding allocations were also carried out using an ANOVA coupled with a Tukey’s pairwise comparison.

4.4 Subjects

Subjects in this study were paid adult volunteers recruited from metropolitan parks in the Cleveland, Ohio area. A total of 50 subjects were assigned at random to the SV condition and another 51 subjects were assigned at random to the UT condition. The workbook of one subject was excluded from the SV condition and six were excluded from the UT condition because all of the sections had not been completed; final sample sizes for analysis were therefore 49 in the SV condition and 45 in the UT condition. All subjects were informed that the objective of the study was to obtain input from stakeholders regarding risk management options in a hypothetical state park. They were reminded that there were no right or wrong answers to any of the questions and that their responses would be anonymous.

4.5 Hypotheses

With respect to Component 1 of the experiment, I expected that self-reports from participants regarding the quality of the decision process would be similar to
those found in past studies. In concordance with previous research, I expected that participants in the structured values condition (as opposed to those assigned to the unstructured technical condition) would feel more comfortable with the prospect of providing input to decision makers, more satisfied that their decisions addressed their issue-specific concerns, and more satisfied with their decisions overall. With respect to Component 2, I expected—based on past endorsements of structured decision approaches—that subjects in the SV condition would indeed make choices that more closely reflected their stated priorities (i.e., subjects’ self-reported evaluations would correspond with their stated priorities and final allocation choices).

4.6 Results
4.6.1 Component 1
A within-subject comparison of responses to the six closed-ended questions that began and ended the workbooks in both conditions revealed a significant increase in level of knowledge regarding trails, deer overpopulation, and disease (paired t-test, p<0.01; Table 4.4, Items 1-3). Subject’s responses in both conditions also indicated a significant increase from beginning to end in their ability to identify and understand their objectives for risk management in a nature area (paired t-test, p<0.001; Table 4.4, Item 4). In terms of subject’s degree of comfort with respect to providing input during the risk management process, subjects in the UT showed a significant decrease in comfort from when they started the experiment to when they finished (paired t-test, p<0.001; Table 4.4,
Item 5). Mean ratings from subjects in the SV condition showed no such difference.

For the additional six post-test self-ratings questions, a between-subject comparison also revealed significant differences between responses from subjects in the UT and SV conditions. Specifically, subjects in the SV condition reported being better able to address the issues that mattered most to them when making decisions about managing risks in the state nature area that was the focus of this experiment (2-sample t-test, $p<0.05$; Table 4.4, Item 6). Likewise, subjects in the SV condition also reported being more satisfied with their decisions overall (2-sample t-test, $p<0.05$; Table 4.4, Item 7).

4.6.2 Component 2

With respect to the objectives ranking exercise (Figure 4.2), participants in the SV condition identified—on average—improving environmental health as their primary concern ($\bar{x} =1.69$, SE = 0.106) followed by improving human health ($\bar{x} =1.94$, SE = 0.147), improving recreational opportunities ($\bar{x} =2.9$, SE = 0.114), and addressing aesthetic concerns ($\bar{x} =3.24$, SE = 0.135). Sixteen of the 49 subjects in the SV condition ranked environmental health as their number one concern, 16 subjects ranked human health second, 24 subjects ranked recreation third, and 26 subjects ranked aesthetics fourth.
With respect to the management priorities exercise (Figure 4.3), participants in the Structured Values condition identified—on average—wildlife disease as their first priority ($\bar{x}=1.51$, SE = 0.102), deer overpopulation as their second priority ($\bar{x}=1.86$, SE = 0.105), and damaged trails as their third priority ($\bar{x}=2.53$, SE = 0.093). Thirty of the 49 subjects in the SV condition identified wildlife disease as their first priority, 22 subjects identified deer overpopulation as their second priority, and 30 subjects identified damaged trails as their third priority.

In terms of subjects’ funding choices (Figure 4.3), the largest average amounts were allocated to the problem of wildlife disease ($\bar{x}=$$204,490$, SE =$11,406$), followed by deer overpopulation ($\bar{x}=146,939$, SE = $9,907$) and damaged trails ($\bar{x}=122,755$, SE = $9,578$). Analysis of variance followed by a Tukey’s pairwise comparison of funding allocations revealed differences ($F=16.53$; $p < 0.001$) that were concordant with subjects’ initial affect ratings (funding for disease was significantly different from deer overpopulation and damaged trails; allocations for deer overpopulation and damaged trails were not significantly different).

4.7 Discussion

Previous studies have suggested that the main strength of structured decision making approaches rests in their ability to enhance decision quality by helping people make choices that better reflect their values. This hypothesis has been tested by relying mainly on self-reports from participants. The objective of the experiment reported here was to conduct an evaluation of a structured decision
making approach by comparing these self-reports with actual priority-setting and choice behavior in a realistic risk management setting.

To address the first hypothesis (that participants in a structured approach would feel more comfortable with the prospect of providing input to decision makers, more satisfied that their decisions addressed their issue-specific concerns, and more satisfied with their decisions overall), it was necessary to compare the self-reported evaluations made by subjects that took part in the UT and SV conditions. The results supported this hypothesis. Participants in the SV condition indicated significantly higher levels of satisfaction with both the degree to which their allocation choices addressed their objectives and their decisions overall when compared to subjects in the UT condition (Table 4.4; items 6 and 7). Similarly, subjects in the SV condition reported feeling more comfortable with the prospect of providing input during the risk management process (Table 4.4; item 5) when compared to their counterparts in the UT condition (whose comfort level actually declined from the beginning of the study to the end). These findings are virtually identical to results from other studies. The level of agreement between the experiment reported here and previous studies is all the more striking when comparing our findings with others' (e.g., see Arvai et al. 2001) regarding subjects' self-ratings of (1) their level of knowledge and (2) the degree to which they understand their objectives as they relate to risk management.
Clearly, the incorporation of values-based information (relating to recreational opportunities and aesthetic concerns in this case) seems to provide benefits to decision makers. Stakeholders' values are at the core of all risk management debates and making their consideration an explicit component during the decision making process ought to help people to make choices that better reflect their issue-specific concerns (Keeney 1992). Moreover, as many of the stakeholders that take part in risk management processes are not technical experts (as was the case with the public sample drawn for this study), an added emphasis on non-technical values and objectives during decision making likely provides much needed context and helps participants to access their own areas of "expertise" when making decisions (Arvai et al. 2001). The lack of these benefits in the UT condition may account for the relatively high incompletion/dropout rate among subjects that was observed (see Section 4.4).

Recent research conducted in the context of the evaluability hypothesis (Hsee 1996, Hsee 1998, Slovic 2000) supports these assertions; specifically, linking technical data to additional information that reflects non-technical concerns helps to bring "meaning" to the numbers. Because non-expert stakeholders are typically unaccustomed to considering risk problems in purely technical terms (Slovic 1987), the technical attributes of risk are often difficult to evaluate in isolation. However, presenting this same data alongside easier-to-evaluate values-based information likely helps to provide much needed context for decision makers' evaluations of the consequences associated with a given risk.
An added benefit of incorporating values-based information in risk management decisions of this type relates to easing the burden associated with making tradeoffs. For example, subjects in the UT condition had little choice but to make a tradeoff between addressing risks to the environment (specifically to terrestrial mammals, birds, fish, etc.) or the risks associated with a variety of frightening illnesses or even death. These types of exclusively technical tradeoffs are extremely difficult to make and may represent a form of constitutive incommensurability (Tetlock 2000), where individuals feel as though they are being asked to make tradeoffs among attributes that all seem critically important. People end up feeling as though they are forced to subvert some morally significant values in favor of others and this, understandably, creates a conflict. Providing additional, non-technical attributes across which tradeoffs may be made (as was the case in the SV condition of this experiment) may help to alleviate the dissonance associated with these types of choices.

When considering the results from Component 1 of this experiment, it seems clear that incorporating values-based concerns as part of the risk management process may help participants to more thoughtfully consider risk problems because this information is more salient to them than purely technical information. It stands to reason then, that the quality of structured risk management decisions ought indeed to be enhanced as predicted by past research. The results from this experiment with respect to our second hypothesis (limited to subjects in the SV condition due to the previous results),
however, paint a very different picture. Despite subjects' positive self-reported feelings about the degree to which the funding choices they made reflected their objectives, an analysis of their allocations reveals that they did not address the concerns that they identified as being most important. Forty three out of the 49 subjects allocated funds in a manner that did not correspond with their stated objectives. For example, based on the information presented, subjects in the SV condition rated—on average—environmental health risks as their paramount concern, followed by human health risks, loss of recreational opportunities, and aesthetic declines (Figure 4.2). Based on this ranking of concerns and the risk information provided, subjects should have identified management of risks associated with deer overpopulation as their top priority followed by risks from wildlife disease and damaged trails. Their final funding allocations should have matched their priorities. However, despite this ranking of concerns, subjects in the SV condition actually identified wildlife disease as having the highest management priority and also made the largest average allocation of funds to this problem (which, as noted above, actually posed the highest risk to human health; Figure 4.3).

These results point to a disconnect between subjects' prioritization of management objectives, which the self-reported findings suggested were driven by thoughtful analysis of risk information, and the prioritizing of management problems, which appeared to be driven by some other mode of judgment, namely use of an affect-based heuristic. Further analysis of the results revealed that
participants' prioritization of management problems and their funding allocations corresponded directly with their initial affect ratings (as opposed to their ranked concerns). Specifically, mean funding allocations increased as the mean affect scores increased (Figure 4.4). These results demonstrate that subjects' final risk management decisions did not address concerns in the order that they identified during the structuring task, despite their self-reported behavior to the contrary. As a result, these findings do not support our second hypothesis that, in the context of this experiment, decision structuring would lead to concordance between their self-reported evaluations and their actual choice behavior.

What accounts for this discrepancy? One possibility is that the hypothetical nature of the problems coupled with the fact that the magnitude of the risks was similar across the specified attributes may have decreased the level of urgency felt by decision makers. Subjects may have recognized the relatively lower risks associated with the most affect-rich problem (wildlife disease) but judged the marginal utility associated with this difference (as compared to the other problems) to be very small. As a result, subjects may have judged the choice task as not warranting a high level of accuracy and hence, less effort (Johnson and Payne 1985, Payne et al. 1993).

On the other hand, these results provide further evidence for the large role that affective impressions play in judgment and decision making. Specifically, the results reported here suggest that the affective characteristics of the context of a
decision (e.g., affect-rich disease vs. affect-poor trail maintenance) matter a great deal to people when making risk-based management decisions. On the one hand, affect-based heuristics may be employed as a substitute for more cognitively demanding judgment modes in cases where the demands for accuracy in a decision are low. On the other, the affective characteristics of a problem may also override the gains achieved via decision structuring or other more deliberative modes of decision making. A wide variety of real-world examples seem to support this latter suggestion (e.g., heavy investments in fighting the affectively charged "war on terror" while devoting significantly fewer resources on mundane but often higher risk problems such as road safety).

These findings should not suggest that structured decision making approaches are not valuable tools for helping people to make complex (i.e., multi-attribute) risk management decisions. Despite the lack of agreement between self-reports and actual choice behavior outlined in this paper, we believe that SDM approaches are still extremely useful tools for guiding the management of a wide variety of risks. Risk-based decisions are often too complex, and the consequences of management actions too important, to ignore the objectives and concerns of stakeholders that underlie decisions. SDM approaches may still be the only technique that aids participants in a decision making process to accurately identify their objectives and purposefully consider the decision relevant information. Given the appropriate amount of time—and perhaps more importantly, the appropriate degree of attentive facilitation—we are convinced
that SDM approaches are useful for helping stakeholders and decision makers to better address their stated management objectives and understand the consequences of alternative management options (e.g., see Gregory 2000).

Likewise, the self-reported advantages of these approaches have important implications for risk communication. Stakeholders’ desire to take part in risk management efforts along with their levels of comfort and satisfaction while engaged are all factors that should be weighted heavily when considering alternative risk communication (stakeholder engagement) designs (Arvai et al. 2001). The value-focused nature of the risk information presented in this study worked to increase comfort and satisfaction among the participants, which is an important benefit when including non-expert stakeholders in a complex (i.e., multiattribute) risk management process.

However, as Chess and Purcell (1999) point out, the overall quality of a participatory risk management approach should be judged by both process- (i.e., the steps in a structured, decision aiding approach) and outcome- (i.e., decision makers’ ability to utilize these steps effectively) oriented attributes. Despite the process-oriented benefits of structured approaches (measured often through the self-reported evaluations of decision makers) discussed earlier, the overall quality of the approach will decline without successful outcomes (which can only be measured through more intense study of decision makers’ final choices). As a result, the disagreement observed in this study between decision makers’ self-
reported evaluations and their actual choice behavior—and the implications of this finding for the design of future participatory risk management efforts—should not be ignored.
<table>
<thead>
<tr>
<th></th>
<th>Arousal</th>
<th>SE</th>
<th>Arousal</th>
<th>SE</th>
<th>Arousal</th>
<th>SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Damaged Trails</td>
<td>3.48</td>
<td>0.163</td>
<td>3.69</td>
<td>0.186</td>
<td>5.49</td>
<td>0.151</td>
</tr>
<tr>
<td>Deer Overpopulation</td>
<td>3.86</td>
<td>0.125</td>
<td>4.47</td>
<td>0.140</td>
<td>5.76</td>
<td>0.112</td>
</tr>
<tr>
<td>Wildlife Disease</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4.1: Mean affect ratings and standard errors across the three management problems.
<table>
<thead>
<tr>
<th>Unstructured Technical Condition</th>
<th>Structured Values Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Component I</td>
<td>Component I</td>
</tr>
<tr>
<td>• Affect Ratings*</td>
<td>• Affect Ratings*</td>
</tr>
<tr>
<td>• Pre-test questions*</td>
<td>• Pre-test questions*</td>
</tr>
<tr>
<td>• Technical presentation of information and risk levels</td>
<td>• Structured values presentation of information and impact levels</td>
</tr>
<tr>
<td>Component II</td>
<td>Component II</td>
</tr>
<tr>
<td>• Ranking of concerns related to each management problem*</td>
<td>• Ranking of concerns related to each management problem*</td>
</tr>
<tr>
<td>• Budget allocations for management*</td>
<td>• Prioritizing each management problem*</td>
</tr>
<tr>
<td>Component I</td>
<td>Component I</td>
</tr>
<tr>
<td>• Post-test questions*</td>
<td>• Post-test questions*</td>
</tr>
</tbody>
</table>

Figure 4.1: Experimental framework and order of tasks in the unstructured and structured conditions.  
*denotes a dependent variable
### Human Health Risks

<table>
<thead>
<tr>
<th>Injuries (per year in Ohio)</th>
<th>Damaged Trails</th>
<th>Deer Overpopulation</th>
<th>Wildlife Disease</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sprains</td>
<td>75</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Fractures</td>
<td>20</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Cuts/abrasions</td>
<td>40</td>
<td>30</td>
<td>20</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Illness (per year in Ohio)</th>
<th>Damaged Trails</th>
<th>Deer Overpopulation</th>
<th>Wildlife Disease</th>
</tr>
</thead>
<tbody>
<tr>
<td>West Nile Virus</td>
<td>0</td>
<td>10</td>
<td>80</td>
</tr>
<tr>
<td>Lyme disease</td>
<td>0</td>
<td>0</td>
<td>45</td>
</tr>
<tr>
<td>Chronic Wasting Disease</td>
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<td>0</td>
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<table>
<thead>
<tr>
<th>Fatalities (per year in Ohio)</th>
<th>Damaged Trails</th>
<th>Deer Overpopulation</th>
<th>Wildlife Disease</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>3</td>
<td>2</td>
</tr>
</tbody>
</table>

### Environmental Health Risks

<table>
<thead>
<tr>
<th>Wildlife and vegetation disrupted (average percent of species disrupted per square mile)</th>
<th>Damaged Trails</th>
<th>Deer Overpopulation</th>
<th>Wildlife Disease</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mammals</td>
<td>6%</td>
<td>50%</td>
<td>10%</td>
</tr>
<tr>
<td>Birds</td>
<td>5%</td>
<td>60%</td>
<td>25%</td>
</tr>
<tr>
<td>Aquatic organisms</td>
<td>0%</td>
<td>20%</td>
<td>25%</td>
</tr>
<tr>
<td>Trees</td>
<td>15%</td>
<td>20%</td>
<td>10%</td>
</tr>
<tr>
<td>Shrubs</td>
<td>5%</td>
<td>50%</td>
<td>0%</td>
</tr>
<tr>
<td>Decorative plants</td>
<td>10%</td>
<td>50%</td>
<td>0%</td>
</tr>
<tr>
<td>Vegetative dieback (average percent per square mile in Ohio)</td>
<td>10%</td>
<td>90%</td>
<td>0%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Vegetative dieback (average percent per square mile in Ohio)</th>
<th>Damaged Trails</th>
<th>Deer Overpopulation</th>
<th>Wildlife Disease</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5%</td>
<td>35%</td>
<td>0%</td>
</tr>
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</table>

**Table 4.2: Risk information presented only in the UT condition**
<table>
<thead>
<tr>
<th></th>
<th>Damaged Trails</th>
<th>Deer Over-population</th>
<th>Wildlife Disease</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human Health (1-10 scale)</td>
<td>4</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>• Injuries</td>
<td>6</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>• Illness</td>
<td>0</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>• Fatalities</td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Environmental Health (1-10 scale)</td>
<td>3</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>• Wildlife</td>
<td>2</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>• Flora</td>
<td>4</td>
<td>7</td>
<td>1</td>
</tr>
<tr>
<td>Recreational Opportunities (1-10 scale)</td>
<td>5</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>• Hiking and camping</td>
<td>2</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>• Wildlife viewing</td>
<td>6</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>• Hunting</td>
<td>5</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Aesthetics (1-10 scale)</td>
<td>2</td>
<td>5</td>
<td>4</td>
</tr>
</tbody>
</table>

Table 4.3: Risk information presented only in the SV condition
<table>
<thead>
<tr>
<th>Self-rating item</th>
<th>( \bar{x}_{\text{Start}} )</th>
<th>SE( \text{Start} )</th>
<th>( \bar{x}_{\text{End}} )</th>
<th>SE( \text{End} )</th>
<th>( p )</th>
<th>( \bar{x}_{\text{Start}} )</th>
<th>SE( \text{Start} )</th>
<th>( \bar{x}_{\text{End}} )</th>
<th>SE( \text{End} )</th>
<th>( p )</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Knowledge (Trails)</td>
<td>3.1</td>
<td>0.247</td>
<td>4.1</td>
<td>0.217</td>
<td>&lt;0.001*</td>
<td>3.7</td>
<td>0.211</td>
<td>4.4</td>
<td>0.228</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>2. Knowledge (DOP)</td>
<td>3.8</td>
<td>0.238</td>
<td>4.4</td>
<td>0.221</td>
<td>&lt;0.001*</td>
<td>3.7</td>
<td>0.216</td>
<td>4.4</td>
<td>0.168</td>
<td>0.001*</td>
</tr>
<tr>
<td>3. Knowledge (Disease)</td>
<td>3.3</td>
<td>0.204</td>
<td>4.1</td>
<td>0.221</td>
<td>&lt;0.001*</td>
<td>3.7</td>
<td>0.216</td>
<td>4.3</td>
<td>0.214</td>
<td>0.001*</td>
</tr>
<tr>
<td>4. Understanding objectives</td>
<td>3.7</td>
<td>0.227</td>
<td>4.9</td>
<td>0.214</td>
<td>&lt;0.001*</td>
<td>4.0</td>
<td>0.193</td>
<td>5.5</td>
<td>0.168</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>5. Comfort with providing input</td>
<td>5.2</td>
<td>0.224</td>
<td>4.5</td>
<td>0.245</td>
<td>&lt;0.001*</td>
<td>5.4</td>
<td>0.222</td>
<td>5.1</td>
<td>0.227</td>
<td>&gt;0.05*</td>
</tr>
<tr>
<td>6. Choices reflect what matters</td>
<td>--</td>
<td>--</td>
<td>4.9</td>
<td>0.214</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>5.5</td>
<td>0.168</td>
<td>&lt;0.05†</td>
</tr>
<tr>
<td>7. Overall satisfaction with choice</td>
<td>--</td>
<td>--</td>
<td>4.5</td>
<td>0.245</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>5.1</td>
<td>0.227</td>
<td>&lt;0.05†</td>
</tr>
</tbody>
</table>

*p-value reflects a within-condition comparison in both the UT and SV conditions (paired sample t-test).

†p-value reflects a between-condition comparison of post-test question (\( \bar{x}_{\text{End}} \)) in both the UT and SV conditions (2-sample t-test).

**Table 4.4: Within and between-condition comparisons of subjects’ responses to closed-ended self-ratings in both the UT and SV conditions**
Figure 4.2: Subjects’ mean ranks for each objective in the SV condition. Error bars represent standard error. Given the information in Table 3, these ranks correspond—in order—with deer overpopulation, wildlife disease, and damaged trails.
Figure 4.3: Mean management priority as a predictor of mean funding allocations. Error bars represent standard error. Given subjects' ranked objectives (Figure 4.2), relative allocations for wildlife disease and deer overpopulation were expected to be reversed.
Figure 4.4: Mean affect ratings (combined valence and arousal ratings) as a predictor of mean funding allocations in the SV condition. Funding allocations appear to correspond with the initial affect ratings given by participants to the three management problems.
CHAPTER 5

5. COMMENTS ON THE METHOD AND FUTURE RESEARCH DIRECTION

Chapter summary: This chapter describes the effectiveness of structured decision making (SDM) approaches based both on findings from past research and this study. It also explores the potential role of these approaches as a foundation for future decision making processes. The chapter concludes with a short discussion of the need for future SDM research and the direction that this research should take in order to increase our understanding of the effectiveness and potential of these approaches.

5.1 Effectiveness of Structured Decision Making Approaches

Previous structuring research involving SDM approaches has focused mainly on eliciting sound analysis by attempting to balance technical information or "good science" with values-based judgments (NRC 1996). This emphasis on incorporating individual stakeholders' values into a complex, technical decision process is laudable; however, it may result in an evaluative bias toward process-oriented measures of quality, often leaving out measures of outcome quality. As noted earlier in this thesis, these largely process-based studies often utilize self-reported measures of satisfaction to gauge the quality of the specific structured approach. Although self-reports are useful measures of process quality,
structured approaches must also be geared toward generating high quality outcomes. Facilitators of structured approaches should continue to elicit sound analysis by incorporating non-expert values, as well as pursue measures of process satisfaction; however, they should also 1) strive to balance the affective judgments of decision makers with analytic judgments and 2) link process- and outcome-oriented measures of quality satisfaction.

As noted previously, past research has focused on analysis and deliberation, and placed less focus on affective judgments and the role that they play in the decision making process—as well as their effect on the success of structured approaches. Affective judgments are strong and often difficult to overcome because they lay the groundwork for future information processing during decision making (Damasio 1994, Zajonc 1980). My study showed that affective judgments, specifically the use of an affect heuristic, may limit the effectiveness of structured approaches. People may rely too heavily on these affective judgments when making their final decision resulting in a biased outcome that does not incorporate the analytic, deliberative judgments that they made earlier in the process. A future study, which I will build on for my doctoral work, I will look at using methods to enhance evaluability (see Hsee 1998) as a means of overcoming these initially strong affective judgments to the context of a decision in a similar risk management framework. Enhancing evaluability creates a more appropriate, comparative frame to aid the decision maker's evaluation of the important attributes across the objectives. In theory, increased evaluability
should balance affective judgments by providing a more appropriate context for evaluating the difficult attributes of risk (Hsee 1998). Pilot work already conducted in this context, however, suggests that achieving this goal may prove more difficult than initially expected. For example, I found that in both separate and joint evaluation, more funding was allocated to the high affect management problem (e.g. crime), even though the risks for the high affect problem were lower than those for the low-affect problem (e.g. deer overpopulation). The results of this evaluability study also suggest that strong affective responses (e.g. preferences for a high-affect option) will likely prove to be difficult to overcome even when the relative differences between the risks for a low and high affect option are large.

There also has been relatively less focus on outcome quality and more specifically, linking the quality of the process with the quality of the outcome. This past focus on process quality is due, in large part, to previous proclamations that the process of decision making is of supreme importance (von Winterfeldt and Edwards 1986). Although the quality of the process is indeed a high priority in a structured approach, these approaches ought also to result in an outcome that reflects the values and judgments made by participants during the process. A more appropriate measure of decision quality may be to address the ability of participants in a structured approach to actually address what they state as most important to them. In other words, a quality structured process should result in a final choice (outcome) that reflects the thoughtful deliberation that occurred
throughout the process (Chess and Purcell 1999). My study demonstrated that participants do not always address what they say is most important. There was no link between self-reports and choice behavior. In other words, participants did not allocate more funding to the problems that posed the greatest threat to the objectives they had previously stated as most important. Even though the participants' self-reports indicated that they were able to address what they felt was most important (indicating high process quality), the overall effectiveness of the structured approach was relatively low because it did not actually result in a final decision that reflected the values and objectives of the participants. Again, this result was most likely due to an over-reliance on an affect heuristic by decision makers, and an inability on the part of the decision structuring process to debias participants and balance the affective judgments of participants.

5.2 Potential role of the structured approach as a foundation for decision making processes

Based on the limitations and challenges noted earlier, structured decision making approaches may be most appropriate when 1) the differences between attributes of risk (e.g. environmental health, human health, recreation, aesthetics) are high, 2) the context of the decision is "real" (which will always be the case outside of the experimental realm), and 3) when lengthy in-depth deliberation can be encouraged.
In this study, the difference between the attribute risk values was low. For example, the risk ratings across the three management problems in this study only varied from 2 to 6 for all four stakeholder concerns on a scale of 1 to 10 (see Chapter 4, Table 3). These represent relatively small differences, making the three management options seem similar in terms of the level of risk and the future consequences of the decision. The structured approach utilized in this study may have been more successful if the participants were presented with information about risk management options where the magnitude of difference across the various attributes of risk was larger; this, in turn, would serve to make the risk management options appear less similar. In general, when options appear to be similar, participants may feel they are better off minimizing their effort because the accuracy required by the decision is low. In other words, choosing to ignore either the risk information or the results of a deliberative decision process may be the result of a carefully considered accuracy-effort tradeoff. In contrast, if the decision were thought to be more important (as exemplified by larger differences between the risks associated with the options), decision makers may conclude that more accuracy, and hence, deliberative effort is required (Johnson and Payne, 1985).

The preliminary evaluability research described earlier also suggests that larger risk differences between high and low affect options may result in more attention being given to the low-affect option during evaluation, resulting in a higher preference for that option. The initial results detailed earlier showed that
participants placed a higher priority on managing the high affect problem (e.g. crime), even though the risks for the high affect problem were lower than those for the low affect problem (e.g. deer overpopulation). This preliminary study was conducted a second time with larger risk differences between the two management options, and I found that increasing the risk difference resulted in participants placing a higher priority on managing the low-affect problem than they did in the initial study with lower risk differences. These results suggest that when risk differences are small, heuristics will have a powerful influence on choices, but when risk differences are more pronounced there is less reliance on affect and, in turn, a higher level of analytic effort.

Likewise, a similar decrease in effortful deliberation may have affected the success of the structured approach in this research due to the hypothetical nature of the problem context. Although the context and the management problems presented were realistic, the judgments requested of subjects were still hypothetical, as they will be in any experimental study. Using a structured approach in an actual policy or management decision process will most likely result in greater effort and deliberation on the part of the participants because they will most likely believe that a “real” decision is more important and requires more thoughtful consideration than a hypothetical decision. However, outside of the experimental realm it is difficult to establish the correct course of action or define the optimal choice in advance of the decision process. This raises concerns for measuring decision quality outside of the experimental realm.
Structured approaches may also be most appropriate for use during a decision process that encourages lengthy, thoughtful deliberation. Participants in a structured approach must be forced to think deeply about each issue and thoughtfully consider the information provided. Greater deliberation (both in terms of time and depth) would require additional structuring; more than what was included in this study’s experimental approach. Examples of this type of structured deliberation might include focus groups, facilitated small-group sessions, or simply increasing the timeframe for deliberation or level of facilitation during paper-and-pencil experimental tasks of this type to encourage participants to spend more time in analysis and deliberation. There are many examples of structured decision making both in practice and in experimental settings where intense, facilitated deliberation appeared to result in an increased ability of participants to process information and make complex value trade-offs (McDaniels et al. 1999, Arvai et al. 2001).

In summary, SDM approaches show great potential as a foundation for more thoughtful decision making processes, with a few caveats. Specifically, future attempts at utilizing structured approaches for decision making processes should not ignore the role that affect plays in the choices, or the link between process and outcome when determining overall quality. Structured approaches have always been touted as a means of increasing decision quality by encouraging analysis, incorporating values, and increasing process quality. However, the role that affect plays in the final decision, and the quality of that outcome has seldom
been called into question. Structured approaches will be most appropriate when the factors listed above (e.g. risk differences, context, length of deliberation, greater attention to tradeoffs) are considered in order to ensure that affective judgments do not dominate the decision process, and that the outcome reflects the intent of the process, which is to result in choices that reflect the values and objectives of the decision makers.

5.3 Future research direction

Future research into decision structuring and the quality of these types of approaches should continue to utilize realistic risk policy and management issues for decision making. This research demonstrated that even under the most realistic context, it is sometimes difficult for people to take the decision seriously and thoroughly process information that is given to them. However, utilizing a realistic risk setting does make the decision more salient for people and the results provide additional insight into dealing with similar risk issues in the future. Another study, which I will be involved in during my doctoral work, directly addresses this need for research involving lengthy, facilitated structured approaches for dealing with real policy and management problems. The proposed research is designed to 1) meaningfully involve stakeholders in a transparent and innovative approach to explore adaptive management alternatives and 2) develop decision support tools to assist stakeholders in clarifying their understanding of the relationships between risks, benefits, and uncertainty as they relate to the effectiveness of proposed fire management
options. Previously, little effort had been given to effectively merging non-expert concerns with information provided by technical experts, as well as structuring stakeholder participation for the design and selection of innovative management efforts involving adaptive trials. This research intends to explore decision structuring as a means to making more informed judgments regarding adaptive management strategies. The proposed project offers an ideal opportunity to advance theoretical and applied understanding of structured decision making and adaptive management approaches in the context of an important and salient environmental risk.

Future research should also look for new and better ways to ensure a link between self-reported behavior and success (process quality) and actual choice behavior (outcome quality) in real policy and management decisions. The results of this study suggest that post-SDM decision quality may best be measured by a correlation between the stated objectives or values, and the final decision. This measure of quality will continue to be a challenge because it may be difficult to evaluate “real” decisions in this way. First, it may be difficult to identify whether the outcome is truly a reflection of the previously stated objectives at the time of the decision. In a real decision process, it is difficult to predict with 100% certainty what will happen in response to a choice or judgment. In other words, the ultimate success of a decision at meeting or addressing the stated objectives cannot always be predicted at the time that the decision is made because the policy or management strategy has yet to be put in place. Second, it is also
difficult to identify if the outcome is a reflection of the process, or a reflection of the context of the decision. We do not often-- or perhaps cannot often-- build in the robust measures necessary for evaluation, like the affect-based manipulation check utilized in this study. However, this research provides some additional insight into this dilemma and demonstrates the need to further consider this link between process and outcome quality when studying and utilizing structured decision making approaches in the future.
LIST OF REFERENCES


