Engaging Stakeholders for Adaptive Management Using Structured Decision Analysis

Elise R. Irwin, Kathryn D. Mickett Kennedy

Abstract

Adaptive management is different from other types of management in that it includes all stakeholders (versus only policy makers) in the process, uses resource optimization techniques to evaluate competing objectives, and recognizes and attempts to reduce uncertainty inherent in natural resource systems. Management actions are negotiated by stakeholders, monitored results are compared to predictions of how the system should respond, and management strategies are adjusted in a "monitor-compare-adjust" iterative routine. Many adaptive management projects fail because of the lack of stakeholder identification, engagement, and continued involvement. Primary reasons for this vary but are usually related to either stakeholders not having ownership (or representation) in decision processes or disenfranchisement of stakeholders after adaptive management begins. We present an example in which stakeholders participated fully in adaptive management of a southeastern regulated river. Structured decision analysis was used to define management objectives and stakeholder values and to determine initial flow prescriptions. The process was transparent, and the visual nature of the modeling software allowed stakeholders to see how their interests and values were represented in the decision process. The development of a stakeholder governance structure and communication mechanism has been critical to the success of the project.

Keywords: stakeholders, structured decision-making, adaptive management, regulated rivers, socioecological systems

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Introduction

Riverine systems in the Southeast are highly fragmented and managed for hydropower, navigation, flood control, and recreational needs (Irwin and Freeman 2002, Richter and Thomas 2007). These multiple-use systems require innovative approaches for management of both natural and water resources for societal needs (Irwin and Freeman 2002, Poff et al. 2003). Adaptive management is being used as a framework for managing complex riverine systems where (1) management goals conflict and (2) system uncertainty is great. Adaptive management is different from other types of management because it includes all stakeholders in the process, uses resource optimization techniques by incorporating competing objectives, and recognizes and focuses on the reduction of uncertainty inherent in natural resource systems by attempting to reduce it via knowledge acquisition (Walters 1986, Williams et al. 2007). Stakeholders negotiate a starting point for management actions, effects of management are monitored and compared with predicted results, management strategies are adjusted, and the process continues iteratively through the "monitor-compare-adjust" routine. We are actively involved in adaptive management of a southeastern regulated river. In this paper we describe the method by which we involved stakeholders in the framework by engaging them in a structured decision-making process.

Methods

The study system is the Tallapoosa River below R.L. Harris Dam in the Piedmont region of east-central Alabama (Figure 1) (Irwin and Freeman 2002). Management issues in the study reach below Harris Dam revolve around the effects of the hydropower operation on values associated with the general health of the Tallapoosa River ecosystem. In addition, power production and economic development potential in the area are management concerns and valued uses. For a

full description of the study site and management concerns, see Irwin and Freeman (2002).

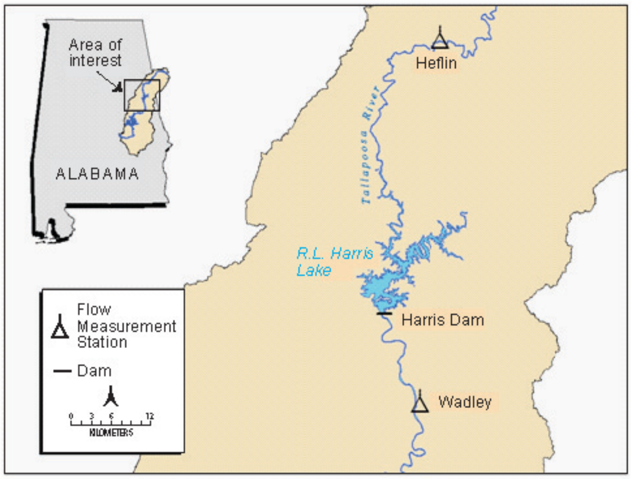

Figure 1. Location of R.L. Harris Dam on the Tallapoosa River, AL, and two USGS gages (Heflin and Wadley) are used to determine specific discharges for flow management.

We conducted a workshop in 2005 to incorporate stakeholder values and objectives into a structured decision-making model. Participants engaged in an open discussion for building consensus on management objectives and values. Presentations by experts in adaptive management of natural resources were followed by a professionally facilitated forum. We used professional facilitators to gather information from the stakeholders in an electronic format (Groupware Systems Software). Suggested objectives were judged in an electronic poll by one representative from 23 participating stakeholder groups. Fundamental objectives were developed and discussed by stakeholders; it was agreed that they were complete and representative of all involved parties. It was also agreed that the framework of adaptive management would be adopted for future discussions and management decisions. In addition, the stakeholders developed a governance structure (the R.L. Harris Stakeholders Board) to assist in future decision-making.

Objectives were used in the development of a decision support model to assist stakeholders in defining the first flow prescription in the adaptive management process. Bayesian belief network (BBN; Marcot et al. 2006) software (Netica 3.19; Norsys Software Corp. 2008) was used to develop a structured decision model.

Results

Stakeholders identified ten fundamental objectives that became the basis for the structured decision model (Table 1). Many objectives were conflicting (e.g., maximizing reservoir water levels and provision of river boating opportunities).

Table 1. Fundamental objectives identified by stakeholders via a facilitated polling process.

Fundamental objective
Maximize economic development
Maximize diversity/abundance of native fauna/flora
Minimize bank erosion downstream from Harris
Maximize water levels in the reservoir
Maximize reservoir recreation opportunities
Maximize river boating and angling opportunities
Minimize total revenues to the power utility
Maximize power utility operation flexibility
Minimize river fragmentation
Minimize consumptive use

Management options (decisions) were also identified by stakeholders and were incorporated into the BBN. The BBN incorporated 3 main decisions, 11 uncertainty nodes (stakeholder objectives), and 5 stakeholder value nodes (Figure 2). The conditional probability tables associated with each uncertainty node and decision were populated with empirical data and information from expert opinion (Kennedy et al. 2006).

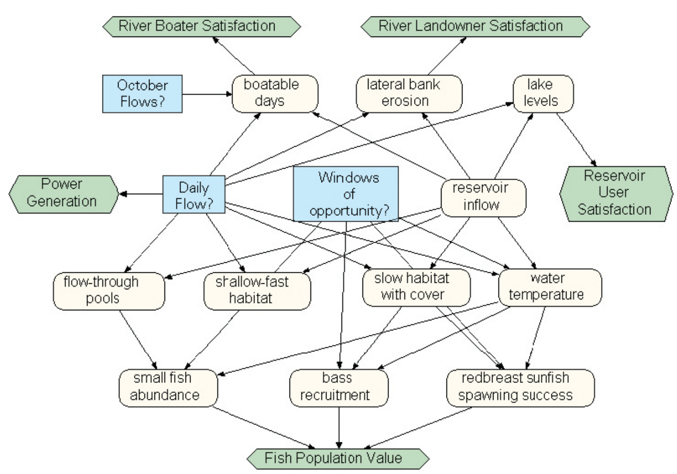

Figure 2. Influence diagram with relational arrows linking nodes included in the Bayesian Belief Network. Three decision nodes (blue boxes), 11 uncertainty nodes (white boxes), and 5 stakeholder value nodes (green hexagons) were included in the model.

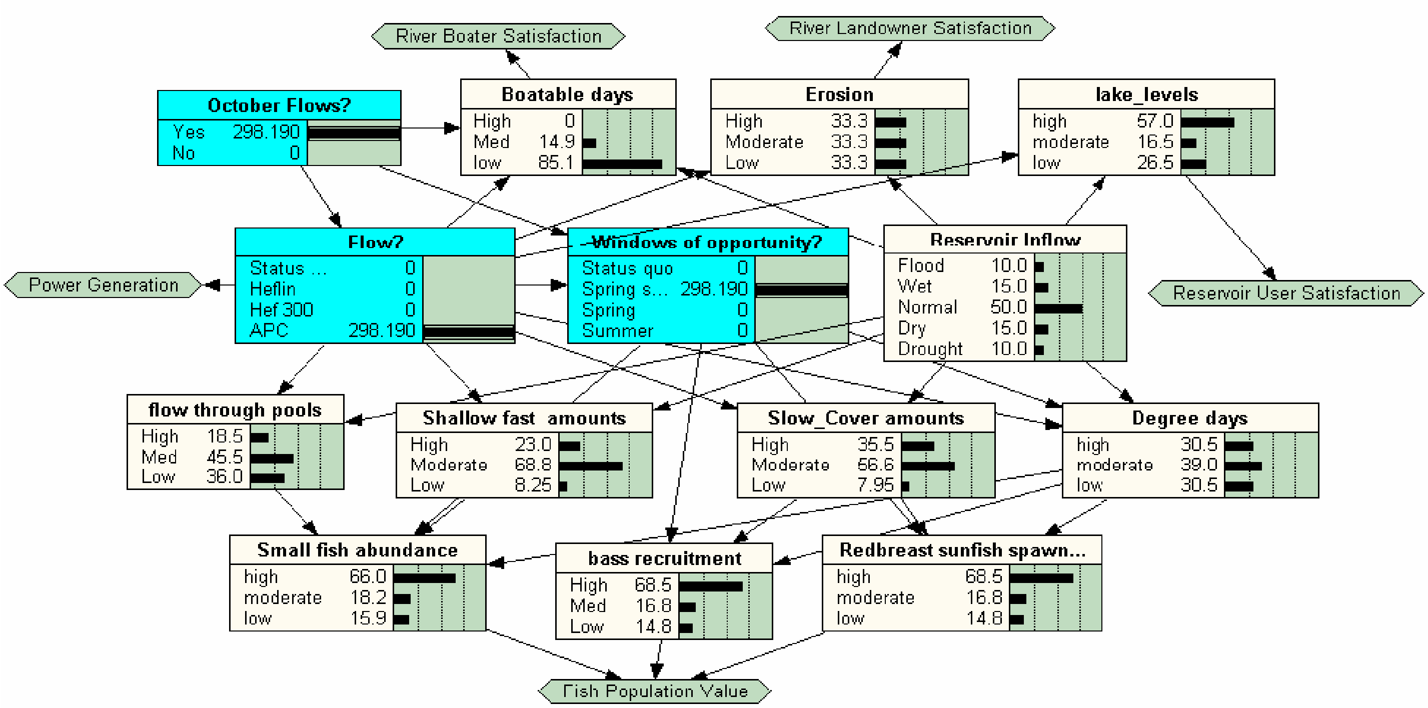

Figure 3. Bayesian Belief Network (BBN) used for structured decision-making regarding flow management below R.L. Harris Dam on the Tallapoosa River, Alabama. The decision model identified initial flow prescriptions that included pulse flows matched to the unregulated river upstream, provision of spawning periods for fish, and provision of boating flows in October. The visual nature of the BBN allowed for stakeholders to understand how the system functioned.

Management decisions were related to daily discharge (volume passed) at the dam, provision of spawning conditions (timing), and provision of October boating flows to mitigate the usual low flows in this month. Optimization was used to determine the management decision that maximized stakeholder values (Figure 3). The initial flow prescription was determined and consisted of pulse discharge from the dam that mimicked the hydrology of an upstream USGS gage in the unregulated Tallapoosa River (Heflin, Figure 1), periods of decreased power generation for fish spawning, and provision of suitable river flows for boating in October. More information regarding the specifics of the BBN can be found in Kennedy et al. (2006).

Conclusions

Quality decision making for resource allocation in complex, multi-use systems depends upon the inclusion of all individuals and groups with an investment in the system. Inclusion of a diverse group of stakeholders as active decision making participants leads to higher-quality management decisions in most cases (Beirle 2002). In addition, stakeholder involvement in decision making increases public education and fosters positive interactions among stakeholders with conflicting interests.

While stakeholders hold a vital role in management decision-making, the literature also suggests that group decision-making is least successful when it is unaided. Rather, groups of people—whether lay people, experts, or both—are most successful at making complex decisions within a structured decision process (Slovic et al. 1977, McDaniels et al. 1999, Beirle 2002). Bayesian network–based decision analysis tools are capable of providing this structure by linking all measurable variables, valued objectives, and sources of uncertainty within a visual framework supported by conditional probabilities based on empirical data and expert opinion (Netica Software Corp. 2008). Through evaluation of these inputs, stakeholders and decision makers may examine the expected effects of different management scenarios and potential system impacts (e.g., climate change, population growth) (Clemen 1996, Peterson and Evans 2003, Kennedy et al. 2006). The use of such a tool has been a key factor in

successfully engaging the stakeholder group involved with developing management strategies in the middle Tallapoosa River below R.L. Harris Dam (www.rivermanagement.org; Kennedy et al. 2006).

Ongoing successful adaptive management in the Tallapoosa River has also been attributed to continued involvement of stakeholders through their governance structure, commitment to long-term monitoring, and assessment for adjustment of future management regimes. Involvement of stakeholders in conflict resolution is critical to progress in management and evaluation of management. The use of a visual structured decision model that allowed for stakeholder input and optimization of values associated with various decisions was also critical in the process. We have been monitoring the system for 4 years and often stakeholders are involved in the collection of field data. In addition, the stakeholders have exhibited patience relative to reporting of results; updates can be viewed on the website www.rivermanagement.org. Our evaluation of management will ensue in 2009 and our hope is to begin another 5-yr assessment with continued stakeholder involvement and support.

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