Human Dimensions of Wildlife, 8:81–95, 2003

1087-1209/03 $12.00 + .00
DOI: 10.1080/10871200390205138

Taylor & Francis
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Peer-Reviewed Articles

Adaptive Impact Management: An Integrative Approach to Wildlife Management

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Wildlife professionals need better ways to integrate ecological and human dimensions of wildlife management. A focus on impacts, guided by a structured decision process, will orient wildlife management toward rigorous, integrative decision making. Impacts are important socially defined effects

Wildlife managers with the New York State Department of Environmental Conservation conducted initial applications of AIM, and provided valuable insights that were incorporated in development of the AIM process. L. C. Chase, N. A. Connelly, K. K. Smith, and personnel from the Colorado Division of Wildlife offered suggestions that improved the manuscript. Preparation of this article was supported in part by the New York State Department of Environmental Conservation, and the Cornell University Agricultural Experiment Station through Hatch Project NYC 147-403.

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of events and interactions related to wildlife that merit management. To manage impacts we propose adaptive impact management (AIM). This approach has seven primary components: situational analysis, objective setting, development of system model(s), identification and selection of management alternatives, actual management interventions, monitoring, and refinement of models and eventually interventions. Adaptive impact management builds upon strengths of systems thinking and conventional adaptive management, yet differs in that fundamental objectives of management are impacts on society, rather than conditions of a wildlife population or habitat. Emphasis is placed on stakeholder involvement in management and shared learning among scientists, managers, and stakeholders. We describe and assess adaptive impact management with respect to black bear management in New York.

Keywords *adaptive management, decisions, impacts, stakeholders, systems, values, Ursus americanus, wildlife management*

The sociocultural context for wildlife management has changed in recent decades, especially with respect to availability and social acceptability of management technology. For example, recreational hunting, a conventional tool for managing game species, is no longer regarded as the only management technique or even the technique of choice in some situations. Whereas this change is regrettable to some wildlife managers, it may be inevitable in light of another change—declining hunter numbers in some regions of the U.S. (Enck, Decker, & Brown, 2000)—leading researchers to predict that hunting by itself will become insufficient for management of white-tailed deer (Brown, Decker, Riley, et al., 2000). Originally serving only a few interests, the wildlife profession now must develop management programs acceptable to a large and growing array of stakeholders with diverse and often competing stakes in wildlife management. Stakeholder involvement has become a central element of contemporary wildlife management (Chase, Lauber, & Decker, 2001). Wildlife managers are responding to these and other changes in the management environment by adopting management approaches that integrate biological and human dimensions and broaden stakeholder involvement in management.

As part of this shift in management, a reorientation toward impacts of human-wildlife interactions has been suggested (Riley, Decker, Carpenter, et al., 2002). Impacts are significant positive and negative effects, defined in terms of human values, that result from events or interactions involving: (a) wildlife individuals, populations, habitats, and communities; (b) wildlife management interventions; and (c) stakeholder interactions with respect to wildlife (Riley et al., 2002). Events or interactions pertinent to wildlife management can be of several general types: wildlife interactions with other wildlife, wildlife interactions with their environment, interactions between wildlife and humans, interactions between humans and wildlife habitat, and interactions among humans where wildlife is a reason for the interaction. Every instance of such events or

interactions has an effect of some type and degree. Effects are of management concern only if people perceive them and then interpret them as producing impacts (i.e., the effects warrant management attention). These effects may be large or small, positive or negative, but to be considered an impact they must be important to stakeholders.

We propose Adaptive Impact Management (AIM) as an approach to managing impacts. This approach builds upon strengths of adaptive environmental assessment and management (Holling, 1978), but also addresses weaknesses attributed to social challenges in adaptive approaches (Johnson, 1999; Lee, 1999; Walters, 1997). Citizen participation, objectives, systems models, and subsequent management interventions in an AIM process emphasize impacts to society. Habitat or wildlife populations may be foci of management actions, but are only means to achieve impacts, not ends in themselves. A central assumption of AIM is that integrating knowledge from multiple disciplines and engaging key stakeholders in participatory management will increase the probability of identifying important impacts on which to focus management. We believe this tact will promote the societal support necessary for rigorous experimentation needed in adaptive management.

Management of impacts can be accomplished under a variety of frameworks, and AIM may not be appropriate for every management issue. However, an adaptive framework, with emphasis on learning through doing and guidance of structured decision processes, offers promise for advancement of decision-making for the most important wildlife issues society faces. The purpose of this paper is to describe components of AIM and discuss benefits and costs of an AIM approach. We use examples from the early stages of an AIM approach to black bear (*Ursus americanus*) management in New York to demonstrate how AIM concepts can be applied.

Adaptive Management

Wildlife management is just one aspect of resource conservation that is experiencing worldwide adoption of more integrative approaches to management. Other attempts are occurring under the rubrics of ecosystem management (Yaffee, 1999), conservation biology (Meffe & Viederman, 1995), citizen science (Light, Carlsen, Blann, Fagrelius, Barton, & Stenquist, 1998), and community-based conservation (Western & Wright, 1994). Important commonalities among these ideas include: (1) a broad range of knowledge and skills from natural and social sciences must be integrated and applied to conservation issues; and (2) effective, lasting conservation efforts are most apt to result when definition of problems, identification of opportunities, development of solutions, and implementation of management are shared processes among resource agencies and citizens at scales where effects are perceived by stakeholders (Mangel, Talbot, Meffe, et al., 1996). Another central theme of these contemporary approaches is that change is inevitable, and uncertainty and unpredictability are inherent in resource management.

Adaptive management is promoted as a way of embracing such change and uncertainty. Drawing upon systems dynamics (Forrester, 1968) and industrial operations theory (Ackoff, 1970), Holling (1978) and Walters (1986) established a philosophy and techniques for adaptive environmental assessment and management. The vast appeal of adaptive management encouraged its adoption into the lexicon of wildlife management (Lancia, Braun, Callopy, et al., 1996). However, in most respects adaptive management has been more significant as a concept than a management practice (Lee, 1999).

Numerous reviews of adaptive management have been presented (Johnson, 1999; Parma, Amarasekare, Mangel, et al., 1998; Walters, 1997); we will not add to those critiques. Shortcomings in applications of adaptive resource management prompt the modifications proposed here. Models and approaches to conventional adaptive management are primarily based on objectives for a condition of wildlife populations, species, or habitat rather than impacts on society defined by stakeholders (Walters, 1997). Frequently missing are approaches to identification of human values and incorporation of these values in the objective functions of adaptive management (Gilmour, Walkerden, & Scandol, 1999; Johnson, 1999; Lee, 1999). This shortcoming unfortunately leads to a focus on means or enabling objectives rather than stakeholder-defined fundamental objectives (Keeney, 1992). AIM seeks integration of biological or human dimensions considerations rather than exclusively emphasizing one dimension over another.

The Adaptive Impact Management Process

The logic and blueprint for AIM is a modification of adaptive environmental assessment and management (Holling, 1978) that incorporates a value-based, decision-making philosophy (Hammond, Keeney, & Raiffa, 1999; Keeney, 1992). The key difference between AIM and conventional adaptive management is that AIM seeks to define objective functions in terms of desired stakeholder-identified impacts. These objectives become performance measures of subsequent impact management. A focus on impacts and stakeholder involvement will lead to: (1) management of what really matters to society, which will lead to stronger political support for experimental management often lacking in adaptive management programs; and (2) improvements in shared learning among scientists, managers, and stakeholders.

Identification of management goals and objectives in terms of impacts requires early and continuous stakeholder involvement (Shindler & Cheek, 1999). Collaboration may take various forms depending on the scale of impacts (Riley et al., 2002) and the level of stakeholder interest in the issue. Flexibility in forums and processes that accounts for context specificity (e.g., scale of concern) is vital for sustained citizen participation (Chase, Siemer, & Decker, 1999). An appropriate image of the process is improvisational theatre, where the director

(wildlife manager) guides the flow of interactions and analyses, but is capable of adapting to include new actors and techniques as the actual plot unfolds (Payne, Bettman, & Johnson, 1993).

Components of an AIM process, taken stepwise from the point of initializing implementation, include situational analysis, objective setting, model development, identification and selection of alternatives, management interventions, monitoring, and adjustment to models and management (Figure 1).

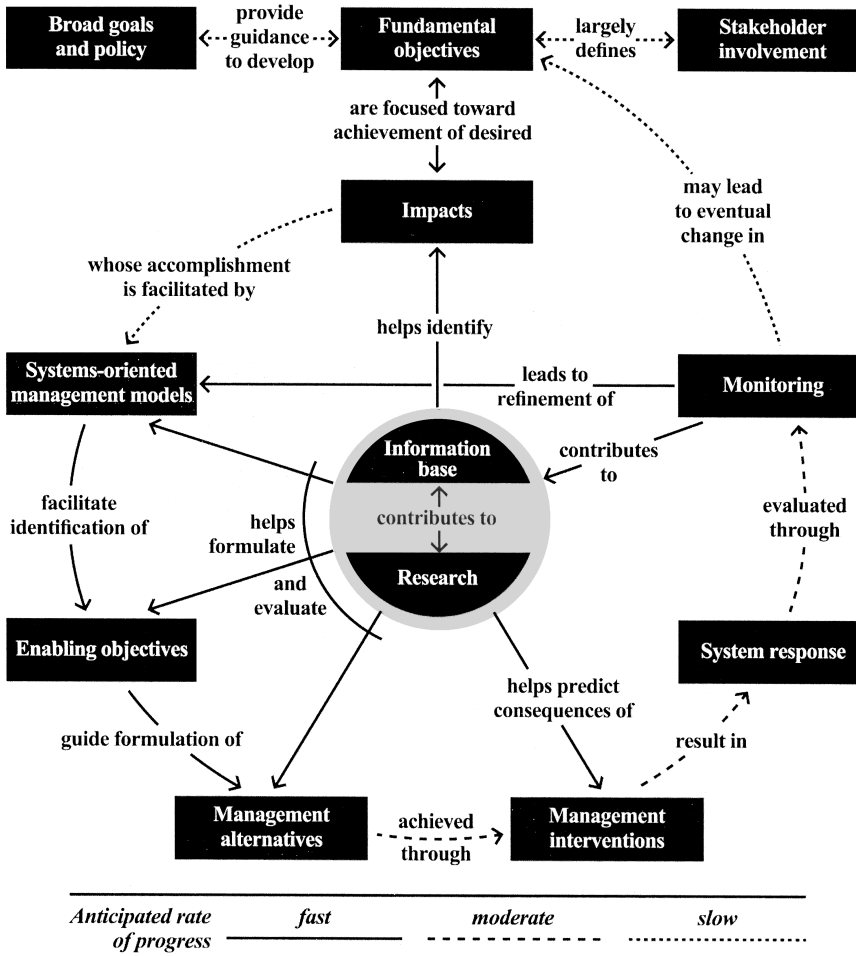

FIGURE 1 The adaptive impact management process, which begins with development of fundamental objectives and leads to monitoring and refinement of systems models, and possibly to changes in fundamental objectives.

Situational Analysis

The principal objective of situational analysis is to frame the decision-making situation (Keeney, 1992, pp. 30–33), by delineating the decision context, identifying potentially relevant impacts (i.e., the expression of values that should be addressed as fundamental objectives), and describing the management environment in which the pertinent impacts occur. Situational analyses use existing information and often new inquiry to improve understanding of what is known about relevant impacts. Knowledge is used to construct a first generation "map" of the management system. This step insures managers and stakeholders are in agreement that everyone is working with the same core data, on the same pertinent issues to be addressed by management. Context-specific stakeholder involvement strategies are developed at this stage (Chase et al., 1999), and stakeholders can play a role in identifying and perhaps even obtaining needed data (Decker, Schusler, Brown, & Mattfeld, 2000).

Decision Framing

Decision framing is a process of central importance in AIM. A public policy decision is "framed by the alternatives and values considered in making that decision" (Keeney, 1992, p. 30). Frames are mental structures people create to organize and simplify the world (Entman, 1993), serving as perceptual "windows" through which people view opportunities or interpret problems, and establish direction for successive management efforts (Hammond et al., 1999). In the absence of interaction, stakeholders can be expected to have different perspectives that influence how they frame decisions; no single stakeholder or decision-maker perspective can provide a complete or comprehensive societal view (Russo & Schoemaker, 1989). Both managers and stakeholders are prone to common decision traps (Russo & Schoemaker, 1989), such as the tendency to focus on means for achieving some end (e.g., how do we reduce the size of the bear population?), without first fully considering the desired ends in terms of impacts (e.g., what ends are we trying to achieve with respect to bear management?).

Perspectives of the management environment resulting from deliberative stakeholder processes greatly influence formulation of fundamental objectives (based on impacts), the management interventions chosen to achieve desired impacts, and the social acceptability of the interventions. An AIM approach can help people avoid some common decision-making traps because it encourages managers and stakeholders to view issues through the same conceptual "window."

In most cases, wildlife agency personnel familiar with the pertinent issues have ample knowledge to conduct situational analyses; however, the assistance of an advisory group of key stakeholders can complement agency perspectives and ensure an open process (Margerum, 1999). Membership in an advisory group should be tailored to the specific issue. Environmental and agricultural

professionals, recreationists, tourism and economic development interests, extension agents, mid-level resource administrators, and independent wildlife scientists are candidates for advisors. The initial range of stakeholders involved depends upon anticipated impacts.

The types of questions to be asked at this point are: (1) what is the range of impacts occurring now and expected in the future; (2) who are the key stakeholders; (3) what are the operational scales (geographical and temporal extent) of the anticipated impacts; (4) what are the capacity and limits of the resource, stakeholders, and management? These four interrelated questions are best addressed simultaneously.

Every event or interaction among people with respect to wildlife, between people and wildlife or habitat, or between wildlife and their environment has an effect of some type and degree. The effects considered most significant by stakeholders are impacts that should attract management attention (Riley et al., 2002). Defining impacts to be managed precisely may not be possible at this early point in the process. Nevertheless, it is possible to anticipate the range and relative importance of potential impacts. This early articulation of impacts is essential for initiating identification of objectives.

Stakeholder Involvement in Situational Analysis

Stakeholder involvement is most effective when it matches the geographical, temporal, and social scale of the issue (Chase et al., 1999). Local citizens and local government generally are most able to address issues affecting their communities. Similarly, regional nongovernmental organizations and state or provincial public agencies should be engaged in issues that involve many communities. Consideration also should be given to matching stakeholders to the duration of expected impacts. For instance, age and duration of residency are important characteristics of stakeholders if factors affecting anticipated impacts occurred for long periods of time and necessitate a long-term perspective.

Determining relevant scales and relevant stakeholders for those wildlife management issues requires careful judgments. These judgments constitute a great deal of the art in the "art and science" of wildlife management (Lee, 1993). Scale of management interventions should be aligned with the scale of impacts managers seek to influence (Bissonette, 1997). Relevant scales for each impact tend to be identified through interactions between stakeholders and managers rather than being determined a priori (Riley et al., 2002).

The level of stakeholders' involvement also must be appropriate to their capacity for involvement and the biological, political, economic, and technological limits of management (Riley et al., 2002). Level of conflict associated with an issue may initially reduce capacity of stakeholders to work toward a common goal (Wondolleck & Yaffee, 2000). Some level of conflict resolution is often required early in the process and certainly prior to applying an adaptive approach

to resource management (Lee, 1999). In some situations it may be possible for communities to coalesce for a broad civic purpose (Schusler & Decker, 2001).

Objective Setting

Goals are statements of intent about the purpose of management, couched as general, long-term conditions to be attained. Bear management in New York is grounded within five major goals (e.g., "Assure that people are not caused to suffer from wildlife or users of wildlife") (Henry, Tripp, Gilligan, et al., 2000). Goals, often established through legislation, lead to objectives essential for directing and evaluating alternative actions to achieve desired outcomes (impacts). Objectives normally are characterized by describing a decision situation, an object, and a direction of preference (Hammond et al., 1999). Objectives form a basis for a set of possible management interventions and evaluation of alternatives. In complex situations, such as wildlife management, it is not always obvious who should formulate objectives. However, objectives formulated through citizen participation are more likely to result in sustained actions because of greater ownership and support by stakeholders (Gregory, 2000). The process of formulating clear, acceptable objectives normally receives inadequate attention compared to its importance (Russo & Schoemaker, 1989), although numerous techniques exist for determining objectives (Hammond et al., 1999; Keeney, 1992).

Fundamental and Enabling Objectives

Two types of objectives are essential to AIM. Fundamental objectives characterize the reason for management in terms of desired impacts. A set of fundamental objectives guides development and evaluation of management alternatives and interventions. A fundamental objective of black bear management could be to increase the psychological well-being of a community in which negative black bear–human interactions are frequent events. Enabling objectives state how fundamental objectives will be achieved. An enabling objective in the black bear example previously could be to increase the level of education about successfully living with black bears in that particular community.

Linking Fundamental and Enabling Objectives

Keeney (1992) suggests linking fundamental and enabling objectives through a listing of process-ends relationships. For each objective, participants should ask, "Why is this important in the specific situation?" The answer either will be that the objective is an essential reason for management (fundamental objective), or the objective is important because it helps attain another objective (enabling). Each fundamental objective should have at least one enabling objective linked to it. Similarly, each enabling objective should be tied to at least one fundamental

objective. A network is created with ties identified between fundamental and enabling objectives. Enabling objectives are initially formulated with fundamental objectives, but are not galvanized until after development of system models.

A black bear management example. The black bear population has been increasing in New York State in recent years, and so have bear harvests, bear sightings, and bear-related complaints to DEC. In response to these and other aspects of the management environment, DEC created a team of biologists and managers to develop a new statewide plan for black bear management.

Staff from DEC is using a sequence of public outreach efforts to identify impacts that will become the basis of fundamental objectives within the statewide bear management plan. The management team began by generated a preliminary list of impacts. They based their preliminary list on insights from an outreach process conducted between 1992 and 1994 to get input on proposed changes in bear hunting and dog training regulations. As a next step, the management planning team worked with human dimensions (HD) specialists, who designed and implemented a series of regional meetings to obtain input on the range of impacts recognized by stakeholders in 2001. Stakeholder informants identified a range of impacts that the researchers organized into six categories. The categories of impacts identified by stakeholder representatives was similar to that identified previously by the bear management planning team based on stakeholder input between 1992 and 1994.

Human dimensions staff used findings from the small group meetings to design a scale to assess bear impacts. This scale was included in a self-administered, mail-back questionnaire being used as the data collection instrument for a statewide black bear management survey implemented in spring, 2002. Among other things, the stakeholder survey will allow researchers to quantify how people are impacted by black bears by state region (e.g., upstate vs. downstate, Catskills vs. Adirondacks), stakeholder group (e.g., hunters vs. nonhunters) and value orientation (e.g., protection orientation vs. use orientation). As a final step in the sequence of outreach efforts, DEC staff will conduct regional, qualitative processes to further refine understanding of stakeholder-defined impacts generated through the statewide mail survey.

Figure 2 displays a partial fundamental–enabling network for addressing black bear management in New York State. A network diagram such as Figure 2 focuses on the means that enable managers to achieve one fundamental objective: maximizing human safety. This fundamental objective has its origins in the safety impacts recognized by stakeholders (i.e., managers understand from recent interactions that stakeholders are concerned about their safety if they are involved in a bear-related vehicular accident, or if they are confronted by a bear). The fundamental objective of maximizing safety has three primary subdimensions: safety of motorists, safety of outdoor recreationists, and safety of people at home. Every element outside the fundamental objective box represents a means to

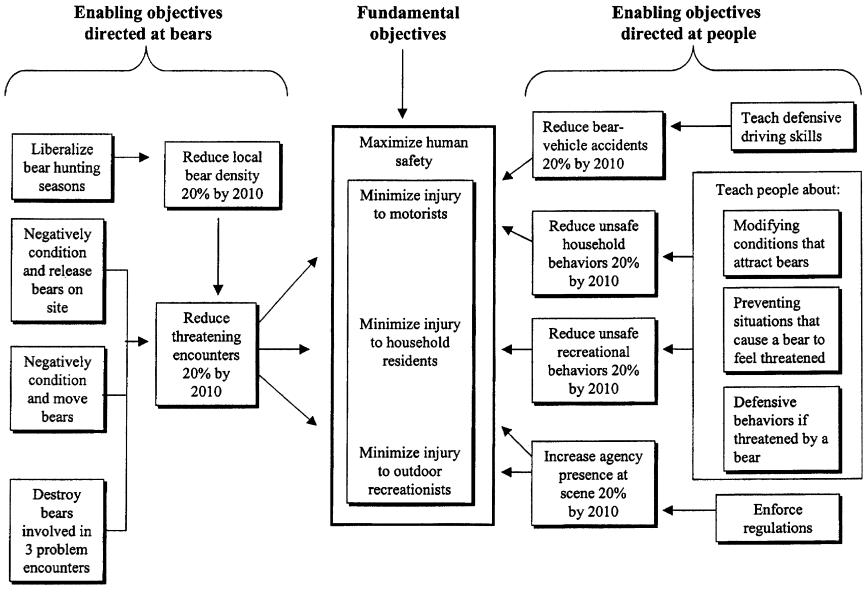

FIGURE 2 A partial means–end network for management of safety-related impacts associated with New York State black bears.

achieve the end of human safety. Arrows in the figure describe which enabling objectives are believed to influence achievement of specific subdimensions of the human safety.

Figure 2 represents only a partial ends–means matrix for decision making with respect to black bear management in New York. In reality, wildlife managers and stakeholders must consider a comprehensive and hierarchical set of fundamental objectives to identify and evaluate a comprehensive range of enabling objectives, and eventually, to identify and evaluate a full range of action alternatives. Creating a complete articulation of means–ends relationships is essential to create an effective decision-making frame (Keeney, 1992, p. 92).

Model Development

Wildlife management involves "messy problems" (Vennix, 1999, p. 380). Wildlife management takes place within ecological and social systems that are highly dynamic and nonlinear (Holling, Berkes, & Folke, 1998). Wildlife management is also contentious because of the diversity of values associated with decisions about wildlife resources. Many attributes under consideration in wildlife management, such as human attitudes, beliefs, and values typically are described qualitatively. Systems dynamics offers three important strengths for developing

AIM: (1) better structure to guide and communicate thinking (Walters, 1986); (2) increased decision-making capacity (Forrester, 1968); and (3) increased rates of learning (Senge & Sterman, 1994).

Lee (1999, p. 5) indicated, "The essence of managing adaptively is having an explicit vision or model of the ecosystem one is trying to guide." Stakeholders seldom have a common understanding of ecosystems or an understanding that can be communicated in a common language. Modeling, especially when done in a group setting, helps organize and communicate the complexity of management systems to managers and stakeholders (Vennix, 1999). Model development also exposes important uncertainties about the management system. With few exceptions, managers perform poorly at making accurate decisions within a multifaceted system such as wildlife management (Kahneman, Slovic, & Tvesrsky, 1982). Many facets of the management system may not even be recognized, let alone understood. Models become highly useful tools for describing and managing a wildlife management system, integrating ecological and human dimensions.

Models encourage examination of proposed management interventions, and help define acceptable sets of management options carried forward through the policy process. Assumptions behind policy changes will be explicit and subject to additional evaluation and improvement. Modeling also leads to systematic identification of information deficiencies that can become addressed by research.

Identification and Selection of Alternatives

In this phase types of potential management interventions are identified and the critical processes and indicators of management performance are explicitly articulated. In formulating alternatives, managers tend to maintain *status quo* or rely on rules of thumb (Russo & Schoemaker, 1989). To counter this tendency, options should not be limited to those believed to be available. Stakeholders often have creative ideas for alternatives and personal perspectives about expected impacts (Gregory, 2000). The key consideration is to continually analyze any proposed intervention (enabling objective) in terms of the fundamental objectives (impacts) expressed by stakeholders.

Management Interventions

It is unrealistic to develop a priori the single best model for a management system. An adaptive mode accepts uncertainties and invites more than one model and management approach. Managers and stakeholders can develop alternative, competing models about the structure of the management system. Probabilities about which may be the "true" model or approach to achieve desired impacts are assigned to each competing model, with a strength of belief depicted by values ranging from 0 (no belief in the model) to 1 (complete belief). Management interventions are then conducted based upon the competing models.

Monitor

An important step, often lacking in adaptive management, is rigorous evaluation of impacts that result from interventions (White, 2001). Primary performance measures are the fundamental objectives identified in the objective-setting step of AIM. Model probabilities are updated through Bayesian analyses based on what is learned after management interventions are conducted (Anderson, 1998). A goal of adaptive impact management is to provide compelling evidence that refines belief probabilities, based on monitoring of management interventions, of one model towards a probability of 1.0. The purpose of this process is to focus impact management under direction of the model believed to be the best representation of the system.

Adjust

System models are adjusted through time with increased knowledge about the management system or as changes occur in the system. With time and experience, confidence systematically improves in the "surviving" model. Management alternatives predicted by models to be viable sometimes fail because of poor implementation. Adjustments must then be made to the implementation process, not to the model structure.

Discussion

Benefits of AIM

By focusing on impacts, AIM is expected to have several advantages over current adaptive management approaches: (1) increased relevancy of wildlife management to society; (2) greater stakeholder satisfaction; (3) managers more apt and capable of embracing change and uncertainty rather than avoiding it; and (4) learning becomes a motivator as well as a product throughout the management system. Because relevant impacts are the primary focus, an adaptive approach—experimental management—should be more readily adopted and implemented by decision makers such as wildlife commissions than current adaptive management efforts (Walters, 1997). The inclusion of stakeholders in the development and refinement of AIM models, as well as in implementation and evaluation of management interventions, should put wildlife management in a favorable political atmosphere (Chase, Lauber, & Decker, 2001). Less use of legislative referenda processes can be an outcome of greater stakeholder participation and achievement of desired impacts (Loker, Decker, & Chase, 1998). Most importantly, this approach will help managers stay agile in an ever-changing management environment by discouraging a static, one-model-fits-all approach.

Costs of AIM

The adaptive or experimental portion of AIM may not always be chosen for many justifiable reasons (Walters & Green, 1997). An adaptive approach is not likely to be cost-effective if the opportunities for making major changes to policy are not favorable. Potential gains in learning are not achieved if the only changes made in management interventions are incremental or slight (Walters & Holling, 1990). The potential for learning increases with the magnitude of management interventions.

Some management costs may increase with AIM. There is a learning curve and new expertise will be needed. Agencies will need to strengthen expertise in socioeconomic disciplines and employ effective facilitators to maintain a neutral position in decisions. Whereas systems modeling aspects may be a barrier to some potential users, availability of user-friendly software such as Stella II (High Performance Systems, Hanover, NH) should increase understanding and facilitate modeling. More important than modeling skills are positive attitudes and willingness among managers to experiment and take risks.

Future effectiveness of wildlife professionals may depend upon their ability to discover and adopt new ways to facilitate stakeholder involvement in impact-oriented management. Structured decision processes, such as AIM, have much to offer wildlife managers as operational approaches. A critical difference offered by AIM over previous methods is employment of stakeholder-identified impacts in fundamental objectives and an emphasis on learning shared among scientists, managers, and stakeholders. Paradoxically, increased stakeholder involvement in decisions may help professional managers maintain, rather than lose, leadership in wildlife management.

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