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Decision-making in Recreational Fisheries Management: An Analysis

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ABSTRACT

A conceptual model of the decision-making process in fisheries management is presented in conjunction with applications of computer and systems analysis to this process. One of the most difficult problems to solve is selecting objectives to be used for management evaluation. An objective function based on some or all of the components of yield, species, size desirability, and environmental quality is needed. Systems analysis and computer technology in data processing and simulation may be used in many situations to evaluate decision alternatives as an aid in developing management strategies.

Dramatic technological advances in our society in the last several decades have often produced equally dramatic changes in natural resource management. Resource managers have witnessed the advent of modern computers, the widespread adoption of management science techniques, the development of a dynamic social structure, as well as the myriad psychological problems associated with rapidly expanding technologies. But technological advances have also allowed the resource manager to deal more effectively with some of the complexities of natural resource systems.

Computer technology is one obvious example of the rapid development in technology. Modern computers can perform routine computational tasks, but this blessing is mixed with the uncompromising demand for sound models in order for the information generated to be meaningful. As processed data become readily available to the decision-maker, more demands are placed upon the individual to make rational use of this increased information.

Originally, most of the "computer-oriented" individuals in resource management were associated with the management science and operations research fields. Their concepts have now spread to ecology and other sciences to the point that *systems analysis* appears to be integral to many disciplines, particularly management aspects of those disciplines (Watt 1966, 1968; Patten 1969). Optimization strategies now appear regularly in the ecological literature (Spivey 1973; Ahmed and Georganas 1973) and "planning" in resource management has been stressed as being of paramount importance (McFadden 1969; Uleck 1971, Gabriel 1970; Phenicie and Lyons 1973).

But through the years, recreational fisheries management, as most of natural resources management, has remained a relatively qualitative field. Statistical methods are common, but many problem-solving tools such as linear programming (Taha 1971), dynamic programming (Bellman and Dreyfus 1962), and decision analysis under risk and uncertainty (Raiffa 1970; Halter and Dean 1971) are neglected. Currently, the newly-graduated fisheries manager is likely to be trained more in data acquisition techniques than in systems management. Since management of fisheries systems is complex and does not readily lend itself to dissection, managers tend to rely solely on experience rather than attempting to formalize strategies. Furthermore, the resource manager has historically been handicapped by staff commitments at such a low level that exploration of non-crises situations has been infeasible.

In a review of potential computer applications in fisheries science, it appears relevant to include a discussion of the decision-making

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process and how computer analysis may aid in this process. As such we will present a diagramatic model of the decision-making process in fisheries management as we perceive it. At each step we will discuss the potential use that computer and systems analysis may have for the manager and what role this analysis may be in decision-making.

THE DECISION MODEL

Decision-making in recreational fisheries management is a complex process, but we have pared it to the bare essentials to facilitate discussion. The conceptual model (illustrated in Fig. 1) is not an original idea since it is followed *implicitly* by most decision-makers, but it is rarely formally defined. By defining the process explicitly, we can discover the areas in which we lack methods or information and determine if computer science and/or systems analysis can fill this gap.

Selecting Objectives—Step 1

The first question we as decision-makers must ask is: What are the objectives? Many objectives in recreational fisheries management revolve around vague terms such as maximizing recreational "benefit" or making "best" use of the resource. These objectives have a strong emotional appeal and are philosophically valid, but they are too ambiguous for developing meaningful management strategies. Quantifiable objectives (even though they might be subjective in origin) which are defined at all levels of the organization, from the local manager to the head, will inevitably make our management more efficient.

Secondly, we must ask if the management objective is achievable. If the "objective" is merely a general direction, there may be no way to evaluate the relative success of management activities, other than by comparative numbers of complaints (Lackey 1974). The achievability of a management objective is contingent upon its measurability; but, how do we measure recreational "benefits"? Historically we have attempted to maximize yield, primarily because it is easy to measure, but in recreational fisheries such an objective neglects other important aspects in the fishing experience, such as species and size preferences (McFadden 1969).

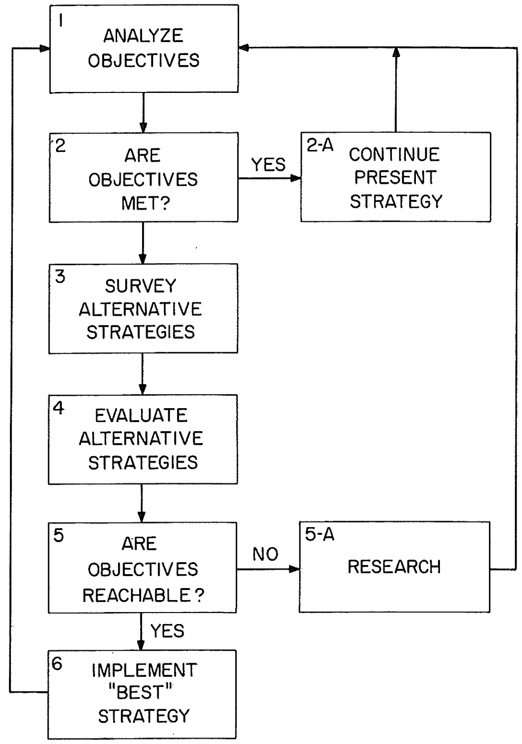

FIGURE 1.—*Simplified decision-making model used to trace representative decisions in fisheries management.*

Then how can we select objectives? The public should supply input by choosing preferences within existing constraints of the resource bio-socioeconomic system. Ranking procedures have been employed on similar problems to determine some public preferences concerning a hunting resource (Lee 1973). Such techniques involve ordinal scales of preference that quantify relative preference while minimizing sampling bias (Churchman and Ackoff 1954). Other indices of consumer behavior (utility) have been developed and/or used by von Neumann and Morgenstern (1947), Halter and Dean (1971), Stimson (1969), Fishburn (1968), and Kennedy (1970). Indices of human behavior allow the decision-maker to maximize individual utility rather than dollar income, total weight of fish removed, or angler-days.

In developing usable measures of management objectives, some basic tenets must be evaluated. Is maximum yield desirable? To an angler, catching fish may be of secondary importance. The quality of the surrounding environment and of the aesthetic experience may be more important (Moeller and Engelken 1972). Therefore, our present research needs include development of a *management benefit unit* which will integrate some or all of the components of yield, species and size desirability, and environmental qualities into a common denominator.

Selection and quantification of management objectives is one of the most difficult problems facing recreational fisheries managers and is by no means a simple task. We need a specific objective toward which we can work. Without one we are subject to random wandering, are easily diverted, and our management lacks continuity.

Are Objectives Met—Fisheries Assessment—Step 2

Initially there must be recognition that a problem exists in a fishery (Fig. 1); indeed, have our objectives been met? Sources for problem recognition and identification traditionally have come from field surveys, receipt of complaints, and prior experience. From these sources the "key" statistics must be identified as indicators of system response and then must be monitored.

If fishery output coincides with the management objective, then management effort will usually be allocated in other areas (Step 2-A). If the objective is not being met, the manager must decide how much money to spend in order to alleviate the problem. In other words, the manager must (within his fixed budget) move the total program toward the objective. Such problems have been addressed by Lobdell (1972) and Bell and Thompson (1973) in the development of management systems concerned with allocation of funds for a state agency's hunting resources.

One means of assessing a fishery in relation to the objectives which is familiar to us all is the creel census. An example of such a census in which computer technology has helped the process is that of the Virginia Commission of Game and Inland Fisheries on state-owned lakes. The census system is computerized for quick tabulation (Zuboy, Lackey, Prosser, and Corning 1974). Using such a system, potential problems may be identified before they become insurmountable. Identification of the key statistics requires adequate financial support, i.e., the monitoring system costs money, but it is necessary for proper management of the fishery.

Survey Alternative Strategies—Step 3

What are the possible ways to meet management objectives? This step involves identification of the decision possibilities, i.e., the available alternatives. These can be enumerated by relating past experience, discussion with other managers, and a review of relevant literature. It must be reiterated that in order to systematically list the alternative decisions a clear objective is needed. Without an objective, alternative strategies are meaningless.

Evaluation of Alternative Strategies—Step 4

Initial evaluation should eliminate those decision alternatives which are technologically infeasible. Many such alternatives can be discarded immediately. For example, it may be infeasible to establish selective harvest between two species because the available harvest methods cannot differentiate between the two. Other alternatives that may be disregarded are those that will obviously exceed a budgetary constraint.

The next step (whether identified implicitly or not) in lowering the number of decision alternatives is in using experience and the literature. What has been the most common procedure? Given similar problems, what was done before? But, it is dangerous to accept these decision alternatives in all cases because it causes perpetuation of the "conventional wisdom" that may have caused the problem. If we analyze alternatives obtained from experience and choose them as the "best" alternatives, then we have made a decision. In essence, we must make a *decision* and if we accept the *status quo*, it must be done because this is the best alternative.

Simple conceptual models may be used to choose from remaining decision alternatives. Such models do little more than force the decision-maker to organize the decision-making process, but this in itself can be valuable. With the advent of programmable calculators, models can be applied to more complicated decision problems, and alternatives may be chosen using a Bayesian decision framework (Halter and Dean 1971).

More complex analytical systems can be developed to evaluate management (Saila and Hess 1975; O'Heeron and Ellis 1975; Patten 1975). These methods employ mathematical and computer models to evaluate the relative success of decisions. Another example is the *CA*tchable *T*rout Fishery *S*imulator (CATS) (Hammond and Lackey 1975). CATS asks the manager to provide inputs relevant to his particular catchable trout fishery and to apply the management decisions. The stocking and fishery statistics are then computed and tabulated for the user. Many computer models are too expensive in time and money for most managers, but time-sharing systems are available to the manager and these may be financially feasible for a management agency. Time-sharing systems could bring the field manager in contact with more complicated analysis and the expense (in relation to the costs of experimentation with the real system) is small.

Other evaluation tools involve the large scale problems associated with diverse resources of a state agency. The agency must allocate its funds to provide the public with the amount and kind of desired recreational experience within bio-socioeconomic constraints (Lobdell 1972).

Are Objectives Reachable—Step 5

At this point the decision-making process is usually re-evaluated. Are the objectives reasonable? Perhaps none of the alternative decisions are capable of meeting the management objectives. In this case the objectives should be restructured. Program re-evaluation is a continual process that is allied with monitoring, as previously discussed.

If the alternatives produce unsatisfactory results the process can revert back to step 1 to recycle through the model again. Perhaps, no feasible solution exists and it would be better to spend time and money on some other activity. Perhaps, doing nothing is the best alternative. Note that this is a positive action, a decision, and very much different than the passive action of not making a decision.

It is important to see where research may fit into our conceptual model (Step 5-A). Research may be used to develop or evaluate a potential management solution. Basic research is needed, but often fisheries research is undertaken within a broader decision-making framework. Management-oriented research should be methodical and problem-oriented (i.e., seeking answers to specific questions). Such a viewpoint does not preclude nondirected research, but it should be identified as such. Basic research may be found in management agencies but more often in academic environments. A government agency will often have to justify to the public the expense of basic research in terms of its objectives. If this cannot be done, basic research will usually be left to academia.

Implement the Best Strategy—Step 6

When the "best" strategy has been identified, it must be implemented, i.e., it must be put into use on the fishery. For example, creel limits may be set or a certain stocking regime implemented. Decisions have been made and the fishery will in part be a product of those decisions, but the decision process does not stop here. Ideally, the system must be monitored to see if the management strategy is effective and the entire decision-making process must be continually re-evaluated. Objectives may change (i.e., people may change their preferences for species) and the fishery itself may be influenced by external factors (subdivisions, road buildings, etc.).

CONCLUSIONS

The value of our decision-making model is that it puts a complex process into a describable system, so that areas of weakness may be identified. The process is then broken down into its solvable components. In our view, the key point in this process is the first step: formulating objectives. Many management decisions fail because the first step is not included.

This model and the more complicated analyses mentioned previously are signs of the evolution of fisheries management from development of techniques to development of strategies. Organizing the decision process will lead to the advancement of recreational fisheries management and fisheries science in general.

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