Computer Applications in Fisheries Science

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SPECIAL SESSION

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ABSTRACT

Most uses of computers in fisheries science can be categorized as: (1) data tabulation, processing, and analysis; (2) automated and semi-automated monitoring systems; (3) educational, especially at the university level; (4) simulation to evaluate management strategies; (5) simulation to learn basic system properties, especially ecological interrelationships; or (6) facilitation of numerical analysis. A problem in renewable natural resource management is determining when and how the use of computer technology is warranted.

Few technological developments have affected twentieth century society as much as has the ready availability of high-speed digital, analog, and hybrid computers. Computer usage has permeated nearly all phases of modern technologically-oriented society and, although it is difficult to distinguish cause from effect, computers have been either heralded as servants of man, or damned as heartless masters. Whatever conclusion one draws, the inescapable fact is that computers are integral to contemporary modern society.

The computer age, as some are inclined to describe the present period in North America, has resulted in harnessing a tremendous and relatively inexpensive analytical capability for man's use. This situation appears inherently desirable, but it has not been without cost, both real and imagined. There are reasons why universities offer courses such as *Computers and Society, Man and the Computer, Computers and the Modern World,* and *Socio-Technological Problems.* Part or all of the potential benefit from technological advance is lost if potential users are unable or unwilling to use the tool.

Resource managers, either directly or indirectly, have been influenced by the ready availability of high-speed computers. My point is not to address the issue whether computer use is a good or bad activity, but *when* and *how* we can use this tool effectively. To what degree computers will improve resource management effectiveness cannot be ascertained at this point, but the use of computers in many situations is very promising.

The most common application of computers in renewable natural resource management is to data tabulation, processing, and analysis. The potential advantages in terms of quantity and speed of data handling are obvious, but less apparent is the problem of determining *when* to implement a computer approach. Unfortunately, there is no simple solution to the problem. Thorough familiarization with computer capability allows a potential user to make "good" decisions on a case-by-case basis, but there are presently few generalizations to assist resource managers who are without extensive computer backgrounds.

A second common application of computers deals with automated and semi-automated monitoring systems. Such monitoring systems may range from remote environmental sensors connected directly to a computer facility, to creel clerks who record data on forms that can be processed directly by computer. In the correct circumstances, such use of computer support can be highly efficient in fisheries management (Zuboy et al. 1974).

A third category of computer usage is enhancement of natural resource education, especially at the university level. Because resource management problems are very complex and dynamic, it is difficult to transmit to students a realistic appreciation of them. Computer simulations of particular resources

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can be used as case studies for students to *practice* management (Titlow and Lackey 1974).

Computer-implemented simulation has become quite popular in ecology and renewable natural resource management in the last few years. The rationale for this approach is that most resource systems are very complex and, although a particular part of the system may be relatively easily understood, the total system cannot be comprehended without substantial assistance with computational and bookkeeping aspects. Computers can handle large volumes of numerical manipulations at relatively low cost and allow the user to manipulate the *simulated* system rather than the *real* system to test hypotheses (Patten 1969).

There are two general approaches to simulation commonly used in fisheries management: simulation to evaluate management strategies; and simulation to learn basic system properties, especially ecological properties. These two approaches are not mutually exclusive, but rather reflect a general orientation of a paticular simulator.

The evaluation of management strategies with the aid of computer-implemented simulators may be considered a fourth, and a very promising, application of computers. Simulation allows the user to cope with the large number of variables inherent in a complex system, and manipulate decision variables to ascertain likely results of a particular set of decisions (Silliman 1969). The management of reservoir fisheries, one of the most formidable problems facing our profession, has been approached with the aid of computer simulation (O'Heeron and Ellis 1975).

The fifth category of computer application involves simulation to improve an understanding of ecological interrelationships. The continual interactive refinement between modeling and data acquisition, and modelers and field personnel, is in itself a vehicle to improve understanding of ecological systems. The biggest problem with this approach, as with many new tools and techniques, is knowing when to use it and in what format (Patten 1975).

A sixth and final class of computer applications involves facilitating numerical analysis. One of the perpetual difficulties in fisheries management is developing *best* strategies. The problem of maximizing (or minimizing) the objective function by manipulating control (decision) variables, subject to system constraints, is the core of renewable natural resource management. Computers can be useful in handling these types of problems (Saila and Hess 1975).

All the computer applications discussed to this point have been used at least to some degree. But what of future computer uses? To answer this question, we must first analyze decision-making in fisheries management because management itself is an application of systems analysis. If a formal analysis of a discipline clearly portrays the present situation, it may be possible to develop a reasonably accurate appraisal of the future (Powers, Lackey, and Zuboy 1975).

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