Computer Assisted Instruction in Natural Resource Management

Franklin B. Titlow and Robert T. Lackey*

**Department of Fisheries and Wildlife*
Oregon State University
Corvallis, Oregon 97331

Citation: Titlow, Franklin B., and Robert T. Lackey. 1973. Computer assisted instruction in natural resource management. *Proceedings of the Southeastern Association Game and Fish Commissioners*. 26: 500-505.

Email: Robert.Lackey@oregonstate.edu
Phone: (541) 737-0569
Web: http://fw.oregonstate.edu/content/robert-lackey

"Reprinted from the Proceedings of the 26th Annual Conference of the Southeastern Association of Game and Fish Commissioners, 1972".

COMPUTER ASSISTED INSTRUCTION IN NATURAL RESOURCE MANAGEMENT[1]

Franklin B. Titlow and Robert T. Lackey
Department of Fisheries and Wildlife Sciences
Virginia Polytechnic Institute and State University
Blacksburg, Virginia 24061

ABSTRACT

Teaching natural resource management is especially difficult because of the importance of experience in making management decisions. Most methods for allowing natural resource students to gain management experience in the classroom have not been entirely satisfactory. Computer implemented simulation of natural resource problems allows educators to provide management experience to students. TROUT, a learning exercise which simulates a coldwater lake fishery, is discussed as an example of the role of these teaching tools.

INTRODUCTION

Effective resource management is based, to a great extent, on prior management experience. Until recently, providing actual management experience to natural resource students in the classroom had not been possible (Lackey and Titlow, 1972). Classroom lectures and textbook readings do not adequately demonstrate application of the principles of natural resource management. Management experience is gained when a student is confronted with a situation and uses his knowledge to make decisions. His evaluation of the consequences of his decisions results in a "learning experience."

[1]The work upon which this paper is based was supported in part by funds provided by the United States Department of the Interior, Office of Water Resources Research, administered by the Virginia Water Resources Research Center as Project A-049-VA.

The best way to gain this experience is by actual management of a resource in the field. Unfortunately, field management is not practical for most university students. The length of time needed to ascertain results of actual field management is too great to fit the tight schedules of university students. Also a natural resource is too valuable to serve as a "managerial guinea pig."

Case studies usually provide the only student involvement with decision making processes in natural resource management. Case studies allow students to make decisions concerning a particular management situation, but there is no system response.

Natural resource management is founded on the accurate evaluation of alternative strategies. Deciding on an optimal strategy is complex, and usually all the data needed to make such a decision are not available. Consider the classical problem of obtaining optimum yield in a fishery. Production in a fish stock varies constantly through time under the influence of many factors: weather, water quality, disease, stock density, competition, predation, and fishing pressure. With a management strategy of too little fishing, stock densities may increase causing excessive competition. If fishing pressure is too great, the stock may be decimated. Further complexing the problem of developing an optimum strategy is the multistage nature of most management processes. This means that the effect of every management decision made is contingent on previous decisions. However, confronting students with complex management situations of this type is vital to natural resource education. One method of teaching natural resource management is based on the use of learning exercises which are computer implemented simulations of real management problems. Simulation has been found especially useful in the study of problems where the operating rules, policies, procedures, and other control elements are under question and where the number of variables is large and uncertainty exists about the inputs, transformation, and outputs from a system (Minden, 1971). Computer simulation of problems to demonstrate principles of business management and military strategy has been extensive, but used only sparingly in natural resource education. Computer implemented learning exercises allow students to actively manage a natural resource in the classroom. Through the use of a remote computer terminal, immediate results are provided for their management strategies. Minimizing the time lag between the decision making process and evaluation of results enhances the learning process.

Downey (1971) discusses the attributes of computer implemented learning exercises as teaching tools:

1. *Active involvement.* Students become actively engaged in the learning process instead of passively listening to a professor's lecture.
2. *Immediate reinforcement.* Students are aware of good decisions and bad decisions as quickly as the computer can process their management plans.
3. *Competition.* There is a great deal of competition between student groups or individual students during exercise use. The element of competition adds excitement and enthusiasm to the classroom atmosphere.
4. *Group interaction.* Students working in groups learn cooperation which is a necessity for a career in natural resource management.
5. *Realism.* Simulation of a natural resource gives a student insights into the basic nature and interrelationships among components of that resource.

Learning exercises offer a new concept in student-teacher relationships. The student has more classroom freedom in that he is able to apply his own ideas, which might be different from those of his teacher, to a management situation. The teacher, acting as coordinator and advisor, is still an integral part of the class. Factors such as self satisfaction derived from goal achievement and peer group acclaim often take the place of the traditional grade in motivating students.

In the introductory fisheries science course at Virginia Polytechnic Institute and State University, three learning exercises are used to supplement lecture, text, and library materials. One of these, TROUT, is designed to illustrate fisheries management principles in a coldwater lake.

TROUT: A LEARNING EXERCISE

Development

TROUT is based on twenty years of management data collected from a real coldwater fishery. The bulk of these data consist of yearly census records which were analyzed to determine the management techniques applied during the creel census period. Also the effect on the fishery of the application of each of these techniques was determined. Alternatives for each management technique were then delineated. For example, the data indicated that creel limit regulations had a direct effect on the yearly harvest of trout from the lake. The three alternatives which represented feasible creel regulations were: (a) 6 fish per day, (b) 20 fish per day, and (c) no creel limit. Management techniques with their alternatives served as a framework for the development of TROUT.

Next, the lake ecosystem was graphically modeled using flow charts to develop an understanding of the relationships between key components (i. e., fish, aquatic vegetation, nutrient materials, etc.). Once the nature of these interrelationships had been defined the graphic ecosystem model was quantified and computer implemented. Exercise and refinement followed until the response of the model ecosystem to various management alternatives matched the response of the real ecosystem. To clarify, if the application of a six fish per day creel limit resulted in a decrease in yield (pounds/acre/year) in the real ecosystem then the model ecosystem should produce a similar result. For additional realism, a random number generator was added to allow for dynamic fluctuation of a fish population as a result of natural causes (e.g., drought, floods, unexpected temperature extremes, etc.).

Use

To begin exercise use, a student carefully studies the description of the fishery. He is told that TROUT concerns a 100 acre coldwater lake supporting a rainbow trout fishery. Angling pressure is high, plenty of natural food is available, and trout growth rates are good. From the description, the student should realize that he is dealing with a potentially excellent fishery. How good it becomes will, of course, depend on his management strategy. Each management alternative is listed so that the student clearly understands what tools are available (Table 1). Familiarity with each of these management techniques facilitates exercise use. The student must manage within a reasonable budget in order to achieve satisfactory results.

After studying the fishery description and the management alternatives, the student is ready to proceed. Exercise use involves either a batch processing procedure or a remote typewriter terminal. With batch processing, the student adds his management decisions in the form of punched data cards to a permanent game deck, then submits the deck to the computer center.

The most efficient method of exercise use involves the typewriter terminal. After developing his management plan, the only action required of the student is entering numbers, like typing on a typewriter, to represent his decisions. Each student is asked a series of eight questions to guide him in entering his management decisions for a particular year (Table 1). After all questions have been answered, an analysis of the fishery for that year is given. The student receives comments that he could expect to get in the field situation (e.g., "The fishermen are complaining to your supervisor") which give him an idea of the effectiveness of his management program (Figure 1). He receives all of this in-

formation without moving from the terminal. There are no card decks to worry about and no data cards to keypunch. The ease of exercise use afforded by remote typewriter terminals helps ensure maximum educational benefits to students.

Each student can manage TROUT for as many years as he desires. Having studied the results of the previous year's management, the student revises his strategy accordingly and again responds to the management questions. This procedure is repeated for the number of years that the student has chosen to manage the fishery. There is no best management plan for TROUT as several different management strategies produce high sustained yield. The student is expected to continue exercise use until he is satisfied with his results and prepare a written justification for his final management strategy.

CONCLUSION

The potential for the use of computer implemented learning exercises in natural resource education is great. Several exercises are currently used in the Department of Fisheries and Wildlife Sciences at Virginia Polytechnic Institute and State University.

SALMON concerns the management of a Pacific salmon fishery. Students must manage catch or escapement in the fishery to achieve maximum equilibrium yield over a multiple year period. The exercise was formulated from a simple stock-recruitment model which shows that a certain adult stock size will provide a certain number of recruits to the fishery.

DAM involves the management of a dual purpose (hydroelectric power and recreation) reservoir system. Students, paticipating in groups of five, assume the roles of a *fisheries manager*, a *power company executive*, a *recreation director*, a *city mayor*, and a *county planning commissioner*. Each group of students must work together to develop the *best* management plan for the reservoir system. During exercise use, students within each group may switch roles in order to develop an appreciation of the types of problems which arise for each manager.

In using SCRAP, the student manages for the optimum yearly harvest of a deer population. WATERLOO concerns the large scale management of an estuarine area. Optimum production of both seafood and wildlife in the estuary are primary objectives of the student manager.

Student response to the use of learning exercises has been excellent. Several of these exercises have been used in special training sessions involving groups of people from outside of the university community; for example, high school students and teachers. In each instance, exercise use was noted to be a highlight of the session.

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Table 1. Management alternatives available for TROUT.

Decision	Item	Alternatives	Cost
1	Stocking Catchables (lbs/ac)	0-∞	$1.00/lb.
2	Stocking Fingerlings (lbs/ac)	0-∞	$2.00/lb.
3	Spawning Ground Improvement	None	None
		100 yds.	$ 500.00
		250 yds.	$1000.00
		1000 yds.	$2000.00
4	Lake Aeration	Yes or No	$1000.00/yr
5	Population Estimate	Yes or No	$ 300.00
6	Creel Regulation	6 fish/day - no size limit	None
		6 fish/day - 6 inch limit	None
		20 fish/day - no size limit	None
7	Gear Regulation	Live bait, lures, and flies	None
		Lures only	None
		Flies only	None
8	Season Regulation	Year Around	None
		June 1 - December 31	None
		June 1 - August 31	None
		April 1 - October 31	None

Figure 1. Results of managing Trout Lake for two years.

RESULTS OF MANAGEMENT PLAN FOR 1973
MANAGEMENT PLAN DEVELOPED BY TITLOW FOR YEAR 1 OF A 2 YEAR PLAN

YOUR PLANT OF FINGERLINGS WAS 4.5 POUNDS/ACRE
THE COST OF YOUR FINGERLING PLANT WAS 900.00 DOLLARS

YOU DECIDED TO MAKE SOME HABITAT IMPROVEMENTS
YOUR CHOICE OF SPAWNING GROUND IMPROVEMENTS WAS 1000 YARDS
THE COST OF THE HABITAT IMPROVEMENTS WAS 2000 DOLLARS

YOU DECIDED TO MAKE A POPULATION ESTIMATE AT A COST OF 300 DOLLARS
YOUR SCHNABEL ESTIMATE IN SEPTEMBER WAS 15594 CATCHABLE FISH IN THE LAKE

WHEN CONDUCTING POPULATION ESTIMATE, FISH WERE OBSERVED TO BE DEEP-BODIED AND LARGE FOR AGE

YOUR CHOICE OF REGULATIONS WERE
A SIX FISH/SIX INCH LIMIT
FLIES ONLY
SEASON OPEN FROM JUNE 1 TO AUGUST 31
WHY ARE YOU USING A SIX FISH/SIX INCH LIMIT REGULATION?

TOTAL MANAGEMENT COSTS FOR THIS YEAR WERE 3200.00 DOLLARS

REPORTS FROM WARDENS INDICATE A RETURN OF ABOUT 2 POUNDS/ACRE/YEAR
POOR FISHING HAS RESULTED IN COMPLAINTS TO YOUR SUPERVISOR

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RESULTS OF MANAGEMENT PLAN FOR 1974
MANAGEMENT PLAN DEVELOPED BY TITLOW FOR YEAR 2 OF A 2 YEAR PLAN

YOUR PLANT OF FINGERLINGS WAS 4.0 POUNDS/ACRE
THE COST OF YOUR FINGERLING PLANT WAS 800.00 DOLLARS

YOU DECIDED TO MAKE SOME HABITAT IMPROVEMENTS
YOUR CHOICE OF SPAWNING GROUND IMPROVEMENTS WAS 100 YARDS
THE COST OF THE HABITAT IMPROVEMENTS WAS 500 DOLLARS

YOU DECIDED TO MAKE A POPULATION ESTIMATE AT A COST OF 300 DOLLARS

YOUR SCHNABEL ESTIMATE IN SEPTEMBER WAS 21111 CATCHABLE FISH IN THE LAKE

WHEN CONDUCTING POPULATION ESTIMATE, FISH WERE OBSERVED TO BE DEEP-BODIED AND LARGE FOR AGE

YOUR CHOICE OF REGULATIONS WERE
A 20 FISH/NO SIZE LIMIT
LIVE BAIT, LURES, AND FLIES
A YEAR AROUND SEASON
PERHAPS A 20 FISH/NO SIZE LIMIT IS TOO LIBERAL?

TOTAL MANAGEMENT COSTS FOR THIS YEAR WERE 1600.00 DOLLARS

REPORTS FROM WARDENS INDICATE A RETURN OF ABOUT 48 POUNDS/ACRE/YEAR
FISHERY DOING WELL. TRY TO IMPROVE IT.

******END OF MANAGEMENT******