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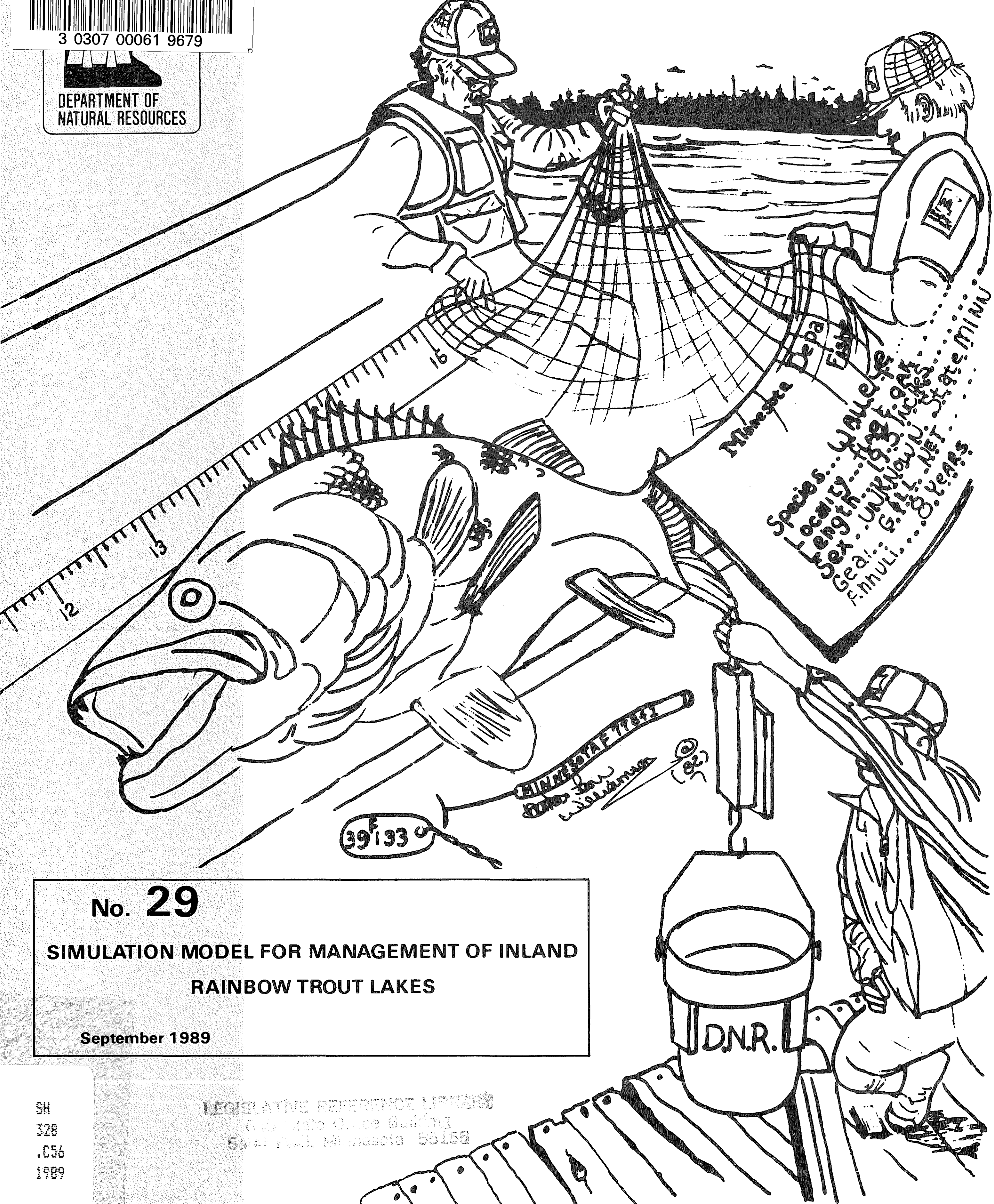

No. 29

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Division of Fish and Wildlife

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Edited by:

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SIMULATION MODEL FOR MANAGEMENT OF INLAND RAINBOW TROUT LAKES[1]

by

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ABSTRACT

RBTSIM is a computer simulation program for management of rainbow trout in reclaimed lakes. Any IBM computer or compatible with at least 256K of RAM and a printer will run the program. The model was developed to test alternative management scenarios for effectiveness in meeting specific goals. The program is user friendly and is designed for use when hard data is limited. No computer skills are required except knowledge of how to turn the computer on. Requests for program disks should be sent to Attn. Charles Anderson, Minnesota DNR, Box 12, 500 Lafayette Road, St. Paul, Minnesota 55155.

INTRODUCTION

Simulation models are tools which can be used to evaluate management activities (i.e. regulation changes) in scenario before implementation so that the probability of achieving management goals is increased. Simulation models have been available for some time (Walters 1969, Gurtin and Murphey 1981, Argue et al. 1983) but most have not been used by field managers because mainframe hardware was not available and the programs were written for sophisticated computer users. Micro-computers are now available at most field stations but simulation software for the machines is lacking. The purpose of this work was to develop a user friendly simulation model of rainbow trout management for novice to advanced computer users assuming a data poor environment.

METHODS

The program was developed from a flow chart constructed according to the logical format suggested by Walters (1986) and is written in the Microsoft version of the BASIC language.

RESULTS

An IBM or compatible computer with at least 256K of RAM, one 5.25 inch floppy disk drive, and a printer are needed to operate the program. The RBTSIM diskette is the only software needed; DOS 2.0 and the compiled program are provided.

Assumptions

Several assumptions were incorporated into the program which the user must be aware of and also assume.

1) All functions are linear.
2) All mortality rates are age, size, and density independent.
3) Spring stocked yearlings are stocked before fishing season opens and are 100% vulnerable to angling.
4) Fall stocked fingerlings are 100% vulnerable to angling in the spring, 1.5 years after stocking.
5) Sixty percent of natural mortality occurs from May through September.
6) Growth is according to the Ford model (Ricker 1975) and the ultimate weight (W_∞) is 50 pounds.
7) If empirical growth data indicates accelerating growth from age 1 to age 3 (slope >1), then growth decelerates (slope <1) after age 3.
8) The potential yield estimate is based on Ryder's sustained yield function (Ryder et al. 1974) for "north temperate" latitude lakes.

Inputs

You will need data about the lake and its actual or potential fishery. If data is not available, an educated guess can be used. Guesses should be reasonable, however. The program asks for:

- Total dissolved solids OR total alkalinity (ppm)
- Average depth OR maximum depth (feet)
- Lake area (acres)
- Natural mortality rate for rainbow trout (V)
- Percentage of total summer's growth that occurs each month
- Total annual yield (pounds/acre) of all other species (excluding rainbow trout)
- Year-end weights as data on growth for ages 1-3
- Number of rainbow trout in the lake at the start of the simulation and their age frequency distribution
- Estimates of fishing effort (summer and winter total hours)
- Percentages of rainbow trout removed by anglers each year (fishing mortality rate)
- Average angling trip length (winter and summer hours)
- Percentage of the total catch landed each month (summer only)
- A stocking plan
    a) How many?
    b) What size?
    c) When? (Spring or fall?)
- Cost to hatch and rear each fish
- Cost to transport and stock each load
- The dollar value to the regional economy of each fishing trip

Outputs

The program will draw line graphs with year on the X axis (up to twenty years can be simulated) and the following dependant variables on the Y axis.

- Summer catch (by number)
- Summer catch in pounds
- Average weight of summer caught rainbows
- Summer CPUE
- Winter catch (by number)
- Winter catch in pounds
- Average weight of winter caught rainbows
- Winter CPUE
- Total catch (by number)
- Total catch in pounds
- Cumulative benefit:cost ratio
- Spring survivors from previous plants

Figure 1 shows an example of an output plot.

Additional outputs that will be helpful in developing and evaluating management plans can be produced. The program will calculate and display the ratio of predicted yield to potential yield based on Ryder's morphoedaphic index (Ryder et al. 1974). The total pounds of rainbows returned to the angler as a percentage of pounds stocked and the total benefit:cost ratio of the scenario are also displayed. Hardcopy outputs of predicted values can be printed either year by year or for the final values in the simulation.

Example Simulation

The output plot in Figure 1 shows the summer CPUE of rainbow trout in Wobegone Lake over a ten year interval. Inputs preceded by an asterisk are not used in the calculations for this example output, but are listed to show their format and that inputs are required for all variables.

-Lake name: Wobegone

*-Total alkalinity: 150 ppm

*-Maximum depth: 50 feet

*-Lake area: 80 acres

-Natural mortality rate: 20%

*-Monthly growth increments (% of a total year's growth):

May, 0%

June, 15%

July, 50%

August, 25%

September, 10%

*-Total annual yield of species other than rainbow trout:

0 pounds/acre

*-Average weight at the end of each summer's growth:

0.5 lbs at annulus 1

0.9 lbs at annulus 2

1.5 lbs at annulus 3

-Number of rainbow trout present before the start of the simulation: 0

-Fishing effort:

500 h in first summer, increasing 10%/y

100 h in first winter, increasing 10%/y

-Exploitation rates:

40% in first summer, increasing 10%/y

20% of the summer fishery survivors, increasing 10%/y

*-Average trip length:

Summer, 2 h

Winter, 2 h

*-Percentage of the catch landed each month:

May, 40%

June, 30%

July, 10%

August, 0%

September, 20%

-Stocking plan: 500, 0.5 lb yearlings each spring

*-Cost to hatch and rear each yearling: $1.00

*-Cost to transport and stock each load: $500 in the first year, increasing by 3%/y

*-Dollar benefit of each fishing trip: $26.00

Figure 2 shows the projected summer CPUE if stocking is increased by 100 yearlings each year, rather than held constant.

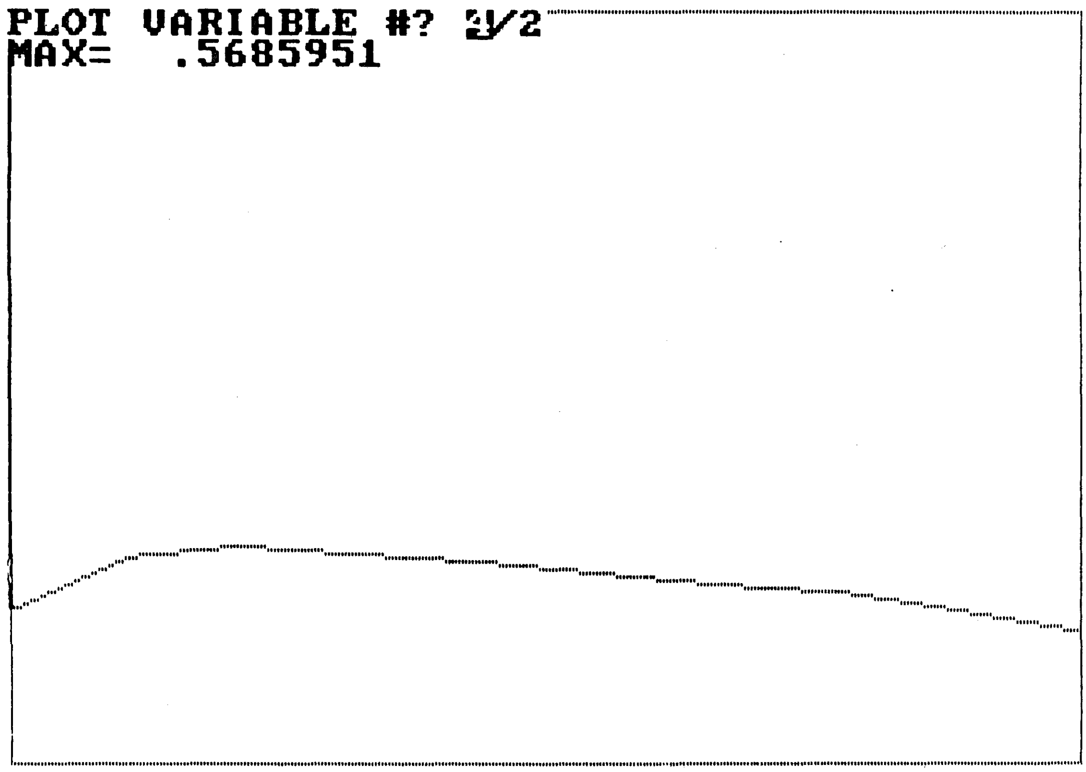

Figure 1. Plot of summer CPUE of rainbow trout over a ten year period given the starting values of the example scenario.

DISCUSSION

RBTSIM is like any other software; you must practice to become proficient. Start with a hypothetical management problem, estimate data values, and try all the options to see what they do. You will find, for example, that the line plots are usually poorly positioned on the screen. Proper line position depends on the variable being plotted so it can't be "corrected" in a generalized way in the program. The "plotting options" screen describes how to change the line position.

Unusual or complicated scenarios can be modeled by breaking them into several stages. For example, you may wish to plot outputs of a scenario where fishing pressure increases for three years at a steady rate then levels off. This scenario cannot be done with one run of RBTSIM because the program allows pressure to increase, decrease, or remain the same, but not increase and then level off. You can simulate this complex scenario with two runs, however. First, simulate the first three years and make hard copies of appropriate output variables. Choose the hardcopy output option that lists the age and size frequency distributions of "surviving rainbows" at the end of the simulation. For the second run, go to the beginning of the program and reenter the input data. When the program asks if the lake will be reclaimed immediately before the start of the simulation, answer "no." Then, enter the age and size frequency distributions of "surviving rainbows." Your second simulation starts where the first one stopped and you have effectively simulated the more complex scenario.

Evaluation of special regulations is an excellent application for RBTSIM. The program will not ask if you wish to change regulations because the program does not work problems in terms of regulations.

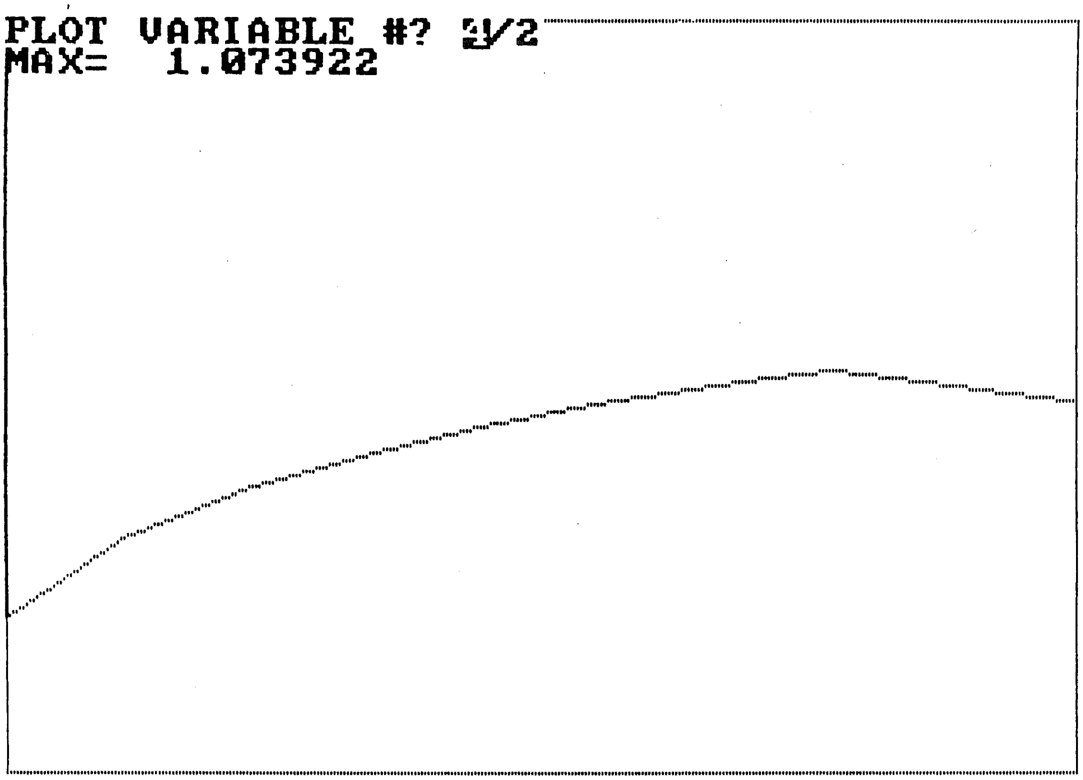

Figure 2. A similar plot of summer CPUE over a ten year period when stocking is increased by 100 yearling rainbow trout each year.

Rather, it works problems in terms of regulation effects. For example, suppose you wish to evaluate the impact of an "artificial baits only" regulation. You must anticipate the effects of the regulation change on the fishery and alter the appropriate inputs. What will that regulation change do to fishing effort, exploitation, natural mortality, growth rate etc. The program will show you the cumulative effect on the fishery.

RBTSIM is unlike most commercial software in that it has not had exhaustive testing before release. Sometimes outputs seem unreasonable but start to make sense after thoughtful consideration. You may encounter "bugs" in the program, however. If you do, try to work your way around them. If that is not possible, try to duplicate the events that led to the problem, writing them down as you go and send the report to the author.

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