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A Users Guide for SAMM: A Prototype Southeast Alaska Multiresource Model

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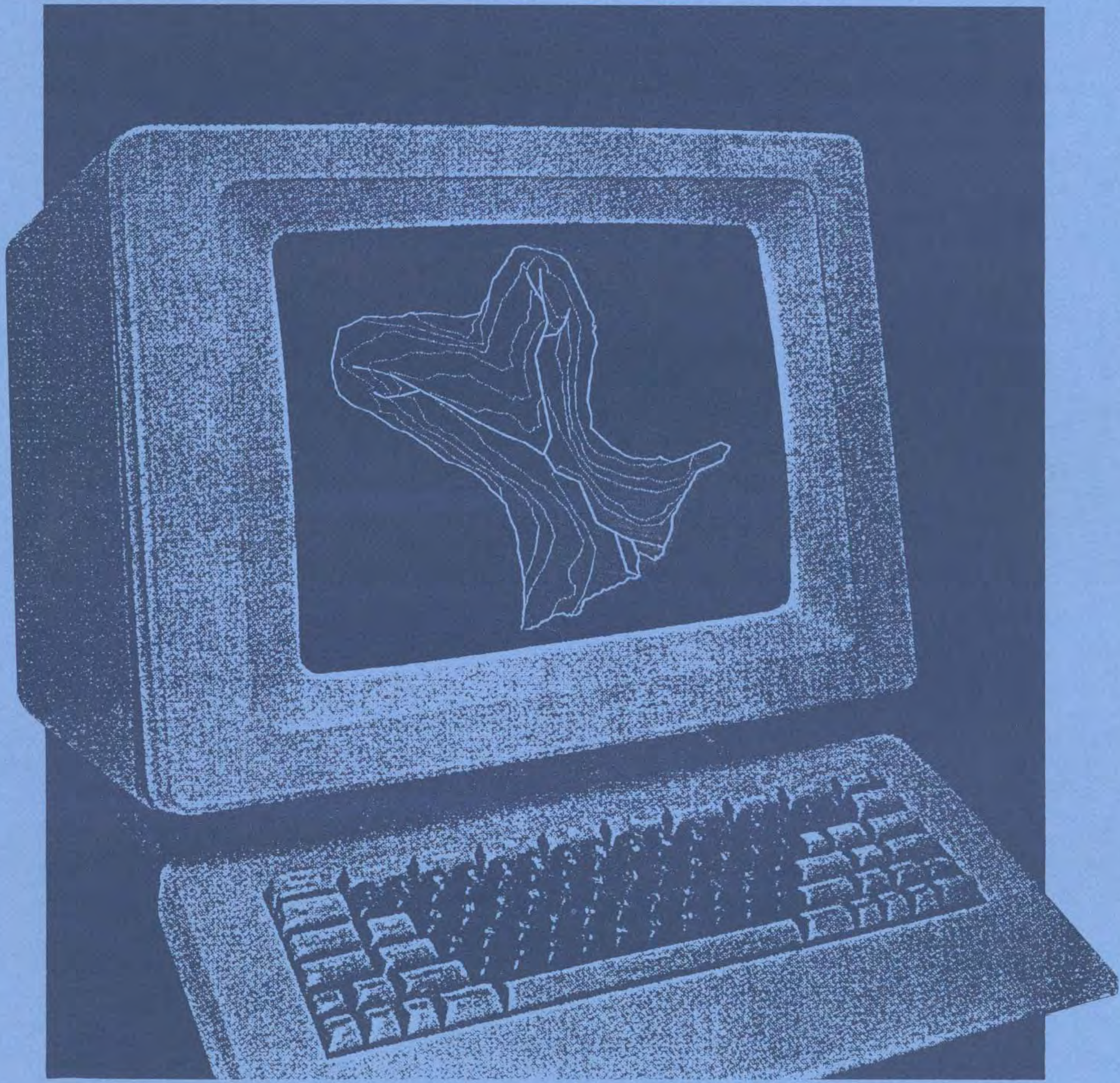

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Abstract

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This paper instructs resource analysts on using the southeast Alaska multiresource model (SAMM). SAMM is an interactive microcomputer program that allows users to explore relations among several resources in southeast Alaska (timber, anadromous fish. deer, and hydrology) and the effects of timber management activities (logging, thinning, and road building) on those relations and resources. This guide assists users in installing SAMM on a microcomputer, developing input data files, making simulation runs, and storing output data for external analysis and graphic display.

Keywords: Multiresource, forest management, software, microcomputer, users guide, models, timber, hydrology, fisheries, deer.

Contents

Introduction

The southeast Alaska multiresource model (SAMM) is an interactive computer program simulating the links among several natural resources in southeast Alaska and the effects of typical management schemes on those resources over time (Fight and others 1990).

Management options are specified for a certain year in the simulation period, and the effects of those options are reflected in the succeeding years. Simulation length is user specified and ranges from 1 to 150 years.

The program is spatially oriented; the user must define the spatial relations between all land areas in the watershed and the stream system draining the watershed. Management options are specified for discrete land units, and their spatial orientation to the stream system is important. The program simulates a single watershed, with the stream system having only one outlet to salt water. Deer herds are confined to the watershed (they cannot leave the watershed for other ranges), and resources are not shared among herds (that is, each herd has an exclusive, user-defined range within the watershed).

All forest area is assumed to be in the old-growth state at the beginning of the simulation and to require 250 years to return to old growth after harvest (logging). Simulations with SAMM are limited to 150 years, however, so logged areas will not return to old growth in SAMM.

General Information About the SAMM Data Files

The sample data files in the appendices are actual data that can be used to run SAMM. These, files are provided on the SAMM distribution diskette (containing the full SAMM model) under the following names:

VCUDATA.TST
HYDRODAT.TST
DEERDATA.TST
PLANDET.TST
ECON.DAT

SAMM data files are text files that can be modified by using any word processor or text editor. If modified, files should be saved as flat, ASCII, or DOS text files or in any format that does not include special word processing control characters (such as tabs, indents, word wrap at the end of lines, and so forth). Files should have hard carriage returns at the end of each line.

SAMM data files are read as unformatted data in the input part of the program. This means that any nonnumeric data must be delimited by single quotation marks. SAMM data files make liberal use of text delimited by single quotation marks as guides for the user in modifying the data; for instance, nearly every data item in file HYDRODAT.TST is preceded by a line of text that is delimited with single quotation marks. These lines of text must not be deleted from the data file. (The line of descriptive text often includes the name of the variable in the program that will read the data item. This variable name is usually in capital letters or in parentheses and is useful only to programmers.)

Unformatted files use blank spaces to separate all data items. Any number of continuous blank spaces are treated as a single blank space. This allows flexibility in lining up data items to make them easier to read (for instance, to justify columns at the right edge.) For this reason, any data item that is zero must have a 0 entered in the file as a place holder. The following two lines of data, for example, would be read identically by the program:

```
1        35.6     0.0       45.2      73
1 35.6 0.0 45.2 73
```

These two lines would yield different results because the data item that has the value 0.0 has been omitted in the second line:

```
1        35.6     0.0       45.2      73
1        35.6               45.2      73
```

In some situations, multiple records of data are read in until an end-data marker is reached. In SAMM, the end-data marker is -99, because this is a value unlikely to be encountered in data. The use of an end-data marker means that the user need not count the number of entries of a certain data item and enter that number into the data file. In VCUDATA.TST, for example, the user need not count the number of spatial units ahead of time, but can simply use the end-data marker to indicate that the last spatial unit has been entered. Refer to VCUDATA.TST for examples of using the end-data marker (appendix 3).

The geographic description of the watershed is input by the user; it can represent data from an actual watershed (geographical information system [GIS] output data, for example) or data from an artificial watershed designed to test management scenarios in a controlled environment.

The model allows only a single simulation per run; that is, the user may wish to run a 150-year simulation with logging and contrast that with a 150-year simulation without logging. This would require two runs of SAMM, and the outputs from each would have to be compared externally to SAMM.

The model allows the user to monitor four resource indicators as the simulation progresses; for example, deer numbers, fish spawners, miles of road built, and deepest snow at sea level. When the simulation period is complete, the user can choose from a menu of 37 graphs (see appendices 1 and 2) and, if desired, replace or overlay graphs showing different variables. Graphs can be printed on a dot-matrix printer.

Once the program is exited, all on-screen graphs are lost, although the data to produce them can be saved on disk files. Disk files can be exported to commercial software, such as Lotus 1-2-3, to produce and print graphs.[1]

[1] The use of trade, firm, or corporation names in this publication is for the information and convenience of the reader. Such use does not constitute an official endorsement or approval by the U.S. Department of Agriculture of any product or service to the exclusion of others that may be suitable.

Watershed Description

The SAMM model is designed to simulate resource interactions over time in a single watershed. The watershed is not bound by acreage limitations, although the model is limited by the number of discrete land units the watershed can be divided into (currently 30 spatial units with up to five site classes each). Spatial units are sections of the watershed defined by stream reaches and elevation. Each spatial unit is further subdivided into one to five site classes, which reflect timber productivity and forest characteristics. Site classes are defined with standard timber classification methods. The program treats each site class of each spatial unit as a separate land unit. Management actions (timber harvest and road building) are specified for a particular spatial unit in a particular year.

Care must be taken in defining the spatial unit boundaries to ensure that runoff from each spatial unit goes to a single stream reach, that each stream reach passes through only one spatial unit. and that the area in a spatial unit can be described by a single, average elevation. Land areas draining to different stream reaches, or land areas crossing a wide elevation gradient, must be subdivided into separate spatial units.

The stream system in the watershed is assumed to have a single outlet to the ocean, with the other streams forming a network feeding that stream. To track sediment flows through the system, streams must be consecutively numbered by the user such that each stream feeds into a successive stream through the network, finally ending at salt water.

Input data files must be edited externally to SAMM, but text comments in each file make them self-explanatory. Input files can be edited with any word processor or text editor.

An example of how a simulation is made is shown in figures 1, 2, and 3.

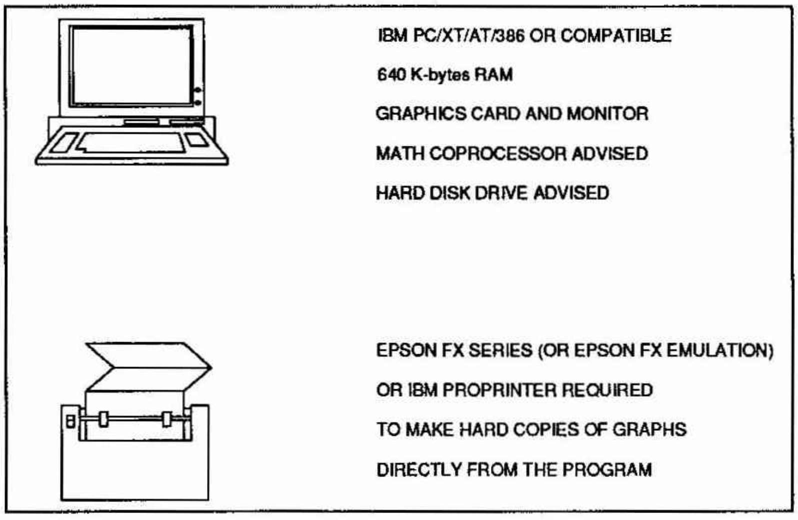


Figure 1—System requirements for running SAMM.

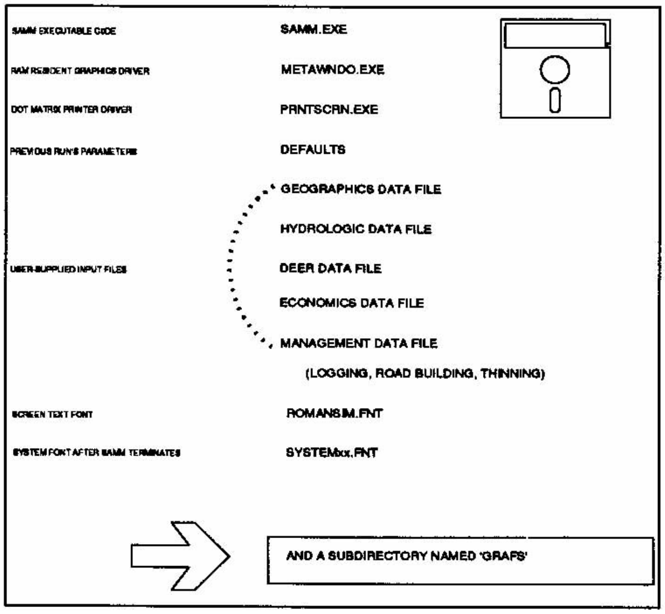


Figure 2—Files that are required to use SAMM.

WHAT YOU TYPE:	WHY YOU TYPE IT:
PRTSCRN	OPTIONAL - THIS LOADS A RAM -RESIDENT PRINTER DRIVER THAT ALLOWS YOU TO MAKE HARD COPIES OF SCREEN GRAPHS AS SAMM IS EXECUTING
METAWNDO	REQUIRED - THIS LOADS A RAM-RESIDENT GRAPHICS DRIVER THAT ALLOWS SAMM TO DISPLAY GRAPHS ON THE SCREEN
SAMM	REQUIRED - THIS ACTUALLY STARTS A SAMM SIMULATION

NOTES:

AT THE BEGINNING OF EACH SAMM SESSION, NOT AT THE

YOU NEED TO TYPE 'PRTSCRN' AND 'METAWNDO' ONLY

BEGINNING OF EACH SAMM SIMULATION

ALL DATA TO PLOT GRAPHS CAN BE DOWNLOADED TO DISK

AND GRAPHED EXTERNALLY TO SAMM BY USING MANY

COMMEHCIAL GRAPHICS PACKAGES

Figure 3—Commands to enter to start a SAMM simulation.

Installation

The minimum hardware system requirements for using SAMM are:

Minimum System Requirements

- IBM-AT or true compatible (model will run on an IBM-PC or IBM-XT class machine, but will require a long time to run a typical simulation)
- Math coprocessor strongly advised (separate version required for machines with no coprocessor)
- CGA, EGA, VGA, or Hercules video card (either monochrome or color)
- 500K bytes RAM available (other RAM resident programs installed at the same time may limit the amount of available RAM memory and may have to be removed before SAMM is run)
- Epson MX or FX series dot-matrix printer or IBM Proprinter to print graphs directly from the screen
- Hard disk strongly advised (program produces a large number of output files)

Step-by-Step Installation

Follow these steps to install SAMM on a computer:

Place the SAMM diskette number 1 into drive A
Make sure the screen shows the A> prompt (if not, enter A:)
To copy to a floppy disk, put a blank, formatted diskette in drive B: and enter COPY *.* B:
To copy to a hard disk, create a subdirectory on the hard disk called SAMM by entering:

```
C:
CD\
MD SAMM
CD SAMM
COPY A:\*.
```
[4]

This will copy the entire diskette to the new subdirectory.

If there is a second SAMM diskette, copy it either to a floppy disk or to the same subdirectory on the hard disk. Backup copies of diskettes should be made by using the DOS COPY command.

SAMM produces output files in a subdirectory called GRAFS. This subdirectory must be created before SAMM is run. If SAMM is run on a floppy disk machine, a formatted floppy disk with subdirectory GRAFS must be available for output (put the floppy disk in drive B:, and enter MD GRAFS). If SAMM is run on a hard disk machine, make sure the prompt is C:SAMM and enter MD GRAFS.

Starting a SAMM Simulation

At this point, SAMM should be properly installed on the computer. Change directories until the computer is in the SAMM directory, or change to drive A if using a floppy disk machine.

Enter METAWNDO to load the RAM resident graphics driver, which produces graphs on the screen (required). This needs to be loaded only once for each SAMM session.

Enter PRTSCRN to load the RAM resident printer driver, which makes hard copies of the graphs on a dot-matrix printer as the simulation progresses (optional). This also needs to be loaded only once each session.

Enter SAMM to start the program.

A SAMM title screen will appear. Press ENTER to access the first menu.

The first menu that will appear is the main menu, which allows the choice of options for this simulation (fig. 4). The parameters for the previous runs are the defaults for the current run.

The option 'ACCEPT PARAMETERS AND NAMES' will be highlighted; to accept the default parameters, simply press ENTER and the simulation will start.

Changing Run Options

Three things can be changed for each SAMM run:

RUN PARAMETERS
DATA FILE NAMES
RUN-TIME GRAPHS

Run Parameters

To change the run parameters, scroll down to the choice 'CHANGE RUN PARAMETERS' and press ENTER. The program will pause briefly and the screen shown in figure 5 will appear. To change any of the parameters, scroll until the desired parameter is highlighted and press the SPACE BAR. For each parameter except NUMBER OF YEARS TO RUN, the space bar will toggle between YES (parameter chosen) and NO (parameter not chosen). To change the number of years to run the model, highlight that option and press the SPACE BAR; a small window will open, which allows a new number of years to be entered. (If a mistake is made in entering the new number, simply press ENTER and then the SPACE BAR to choose NUMBER OF YEARS TO RUN, and reenter the correct number.)

One of the parameters, 'INITIALIZER RUN', is provided as an automatic method for initializing new or changed data sets and is of importance only if the fisheries model is being run. See the section "Advanced Topics" for more information on the initializer run.

The initializer run takes as long as a 100-year simulation, so be judicious in using it.

Data File Names

To change the data file names, scroll to the choice 'CHANGE DATA FILE NAMES' and press ENTER; the screen shown in figure 6 will appear. As before, scroll to the file name to be changed, press the SPACE BAR, and a window will open to allow the new file name to be entered. Some error checking is performed, and error messages are displayed if necessary.

The new file name should correspond with an already created file. The new file typically is an edited version of the default file that has been given a new name; for example, to change the number of acres logged in a given year. load PLANDET.TST into a word processing program (externally to SAMM) and make the appropriate changes. The edited file would be saved with a new name, for example PLAN2.TST. (Be sure that the file is saved without any control characters that are added by some editors. The file should be a flat file [also called a DOS-file, or ASCII file], and should be saved by using export or DOS-save commands.)

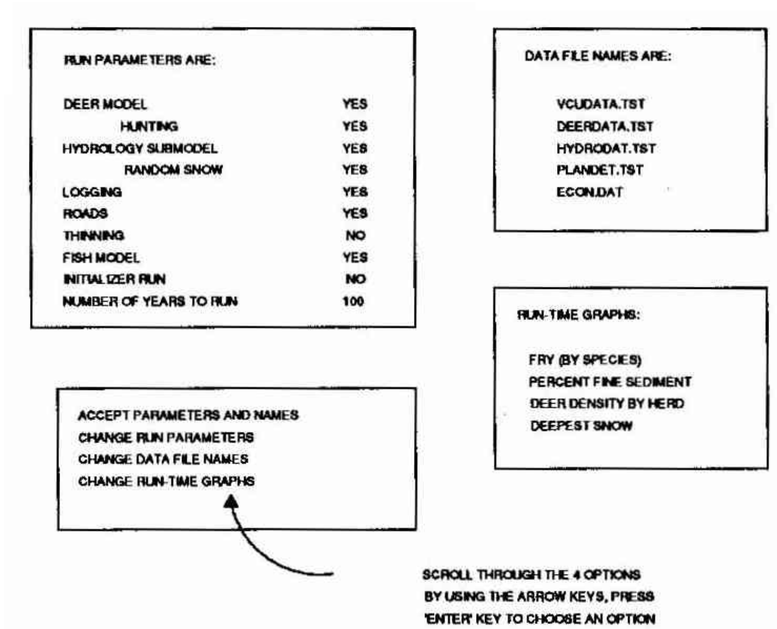


Figure 4—Screen showing main SAMM menu.

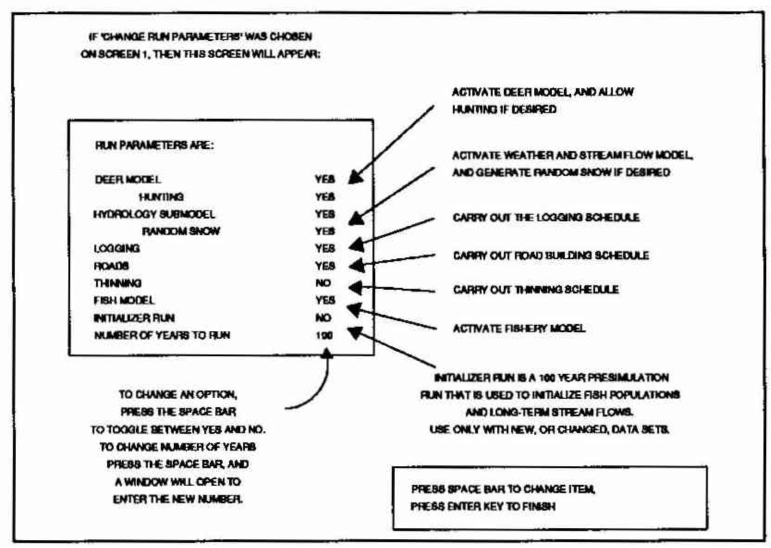


Figure 5—How to change run parameters in SAMM.

Path names are not supported. All input data files must be in the same subdirectory with the SAMM executable code. Input file names must be valid DOS names. File names must start with a letter and have at most eight letters or numbers, followed by a period, followed by an optional three-letter or three-number extension. SAMM does not expect any specific file names or extension. The naming scheme is entirely up to the user. The file names used in this guide and provided on the SAMM diskette are examples only. To correct an error, press ENTER, then the SPACE BAR, and reenter the name correctly.

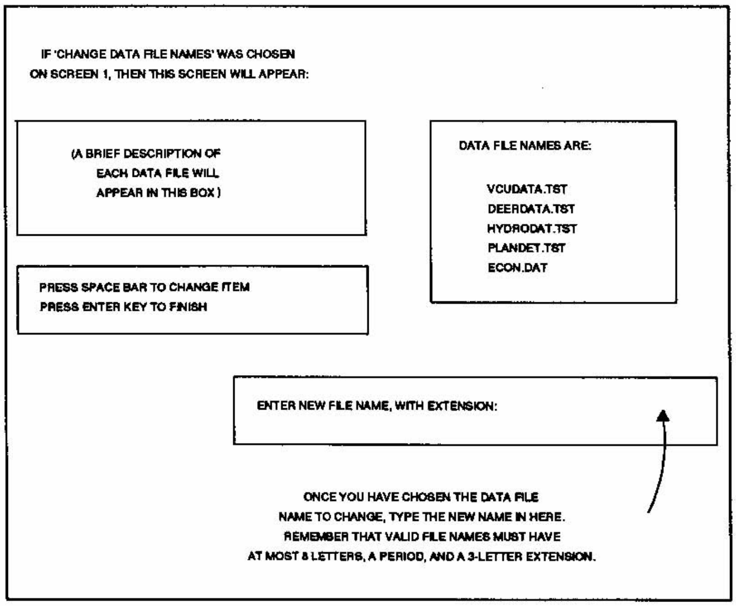


Figure 6—How to change the names of input data files.

Run-Time Graphs

As a SAMM simulation proceeds, graphs showing the changes in four resources are shown on the screen. The graphs change dynamically as values for each year are computed, which allows the user to monitor the progress of the simulation. These four graphs are called run-time graphs.

To change the run-time graphs, scroll to the option 'CHANGE RUN-TIME GRAPHS', and press ENTER. The screen shown in figure 7 will appear. The arrows pointing to four of the graph names are the defaults from the previous run; press ENTER to accept these or scroll to any graph name and press the SPACE BAR to select a graph (the SPACE BAR toggles between selected and not selected). Only four graphs are allowed, and the first four with arrows will be the run-time graphs.

Any graph can be selected as a run-time graph except PRES NET WORTH (TIMBER). This graph can be displayed, however, after the simulation is complete, because all graphs are automatically scaled to the largest and smallest values at that time.

Once all parameters, file names, and run-time graphs have been chosen, select the option 'ACCEPT PARAMETERS AND NAMES', and press ENTER to begin the simulation. If the initializer-run is not run, the four chosen run-time graphs will soon be displayed, and the year counter at the bottom of the screen will count the completed years of the simulation (fig. 8). A SAMM simulation cannot be interrupted before the entire period is complete without a loss of intermediate results. If the simulation is interrupted (by pressing CONTROL-BREAK), all data generated to that point are lost.

Press ENTER when the simulation has finished to bring up the large menu shown in figure 9. Scroll with the arrow keys to choose a graph to display; select it with the ENTER key. This will call the menu shown in figure 10.

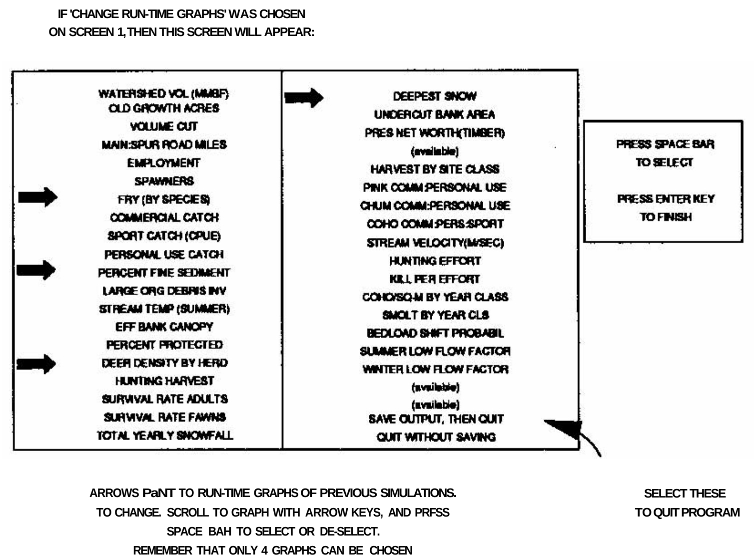


Figure 7—How to choose run-time graphs for display during simulation.

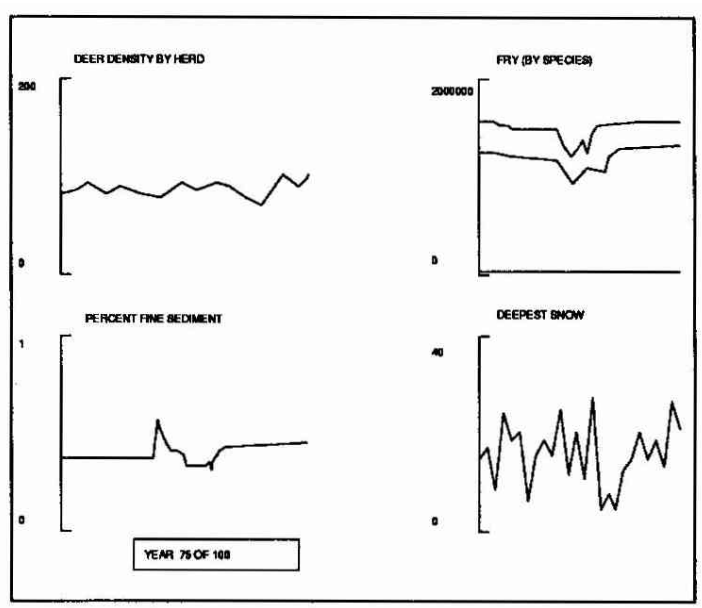


Figure 8—Typical screen during simulation.

The chosen graph can either overlay an existing graph or replace an existing graph. Any number of graphs can be overlaid on the same set of axes, although the result may become confusing. Graphs can be either drawn in a chosen quarter of the screen or scaled to fill the entire screen.

Graphs are automatically scaled to the largest value encountered during the simulation. If graphs are overlaid, each will be scaled to its own largest value, and the y-axis scale values and title will be shown only for the last graph drawn.

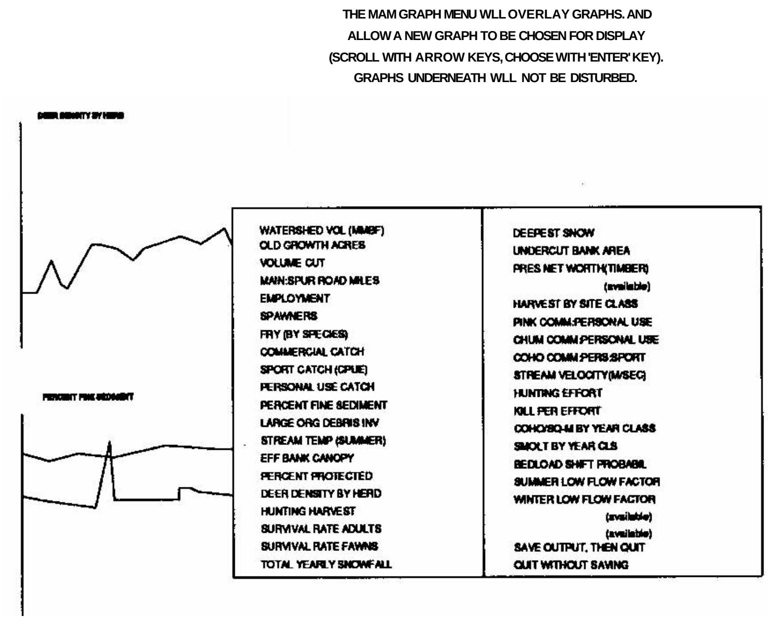


Figure 9—Menu showing available graphs.

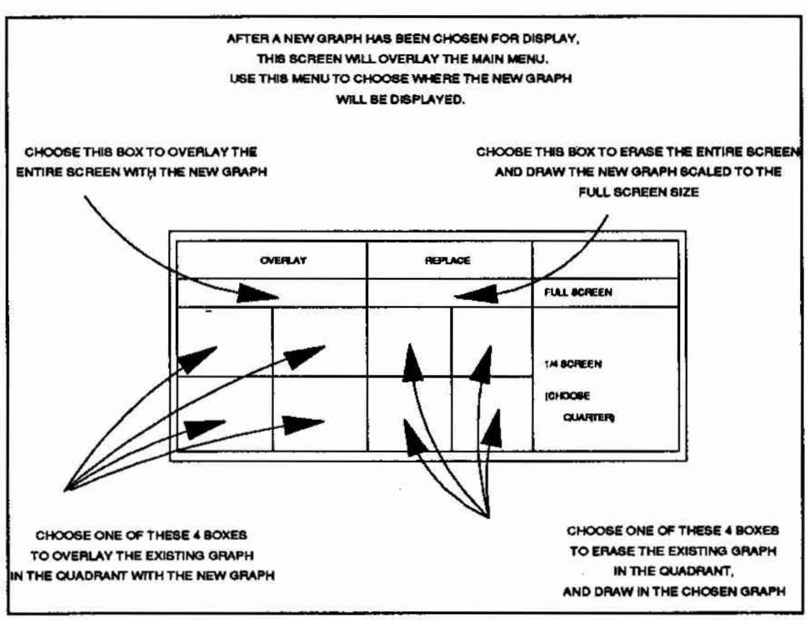


Figure 10—Menu to place graph in different parts of screen.

If the optional command PRTSCRN was entered before program execution and a suitable dot-matrix printer is connected to the computer, then graphs can be printed by pressing the SHIFT and PRTSCRN keys together. This method of printing graphs will .work any time the program is executing (even during a simulation with only partial run-time graphs), thereby causing the program to pause temporarily until the graph is printed. This will produce draft-quality graphs. For presentation quality output, the data must be saved in a file and graphed with a commercial software graphics package (see below).

Quitting the Program and Saving Output

To quit the program, choose one of the last two options in the right column of the graph menu:

'SAVE OUTPUT, THEN QUIT' or
'QUIT WITHOUT SAVING'.

The first option allows the data for any of the graphs to be saved on disk files, and allows data analysis or graphing externally to SAMM (fig. 11). Scroll through the list of graphs and select or eliminate as many as desired with the SPACE BAR; the program will prompt for a three-letter file name extension. This extension will be appended to all output files chosen for this simulation. Output files will be named as follows (EXT is the example user-supplied extension):

GRAFS\GRAPH01 .EXT , the first graph in the menu. WATERSHED VOL (MMBF) and GRAFS\GRAPH11.EXT . the eleventh graph in the menu, PERCENT FINE SEDIMENT.

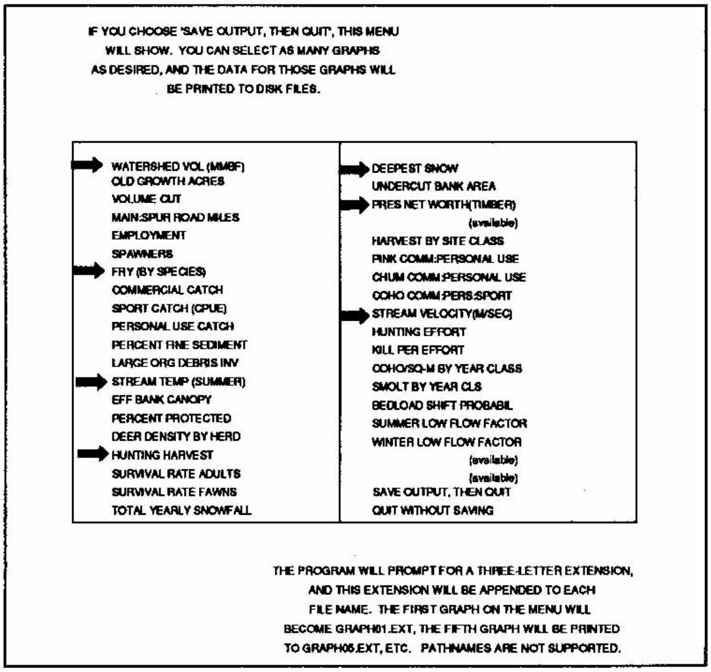


Figure 11—Menu that allows graphs to be chosen for saving to disk.

All output graphs will be placed in subdirectory GRAFS. This subdirectory must be created **before** SAMM is run. Be sure that enough disk space is available for all anticipated output files before making a SAMM run; no provision exists for suspending the program and exiting to DOS to delete some files, then restarting the program. SAMM output files will differ in size depending on the complexity of the watershed (how many spatial units, stream reaches, deer herds, and so forth) and the number of years the simulation includes. Typically, each graph will produce a file between 3K and 50K bytes.

The output file for a particular graph will always have the same root name (for instance, WATERSHED VOL (MMBF) will always be named GRAPH01) with the user-specified extension appended. This allows several runs to be made, with each run having a run-specific extension (such as 001, 002, or 003). Output files for a particular graph from all runs can later be accessed by using, for example.

DIR GRAPH11.*.

This will list output files for the PERCENT FINE SEDIMENT graph from all runs.

Output data files are written as ASCII text files; that is, they have no control characters or graphics characters included. They can be read by most commercial word processing, spreadsheet, or graphics software.

Only those graphs with an arrow next to them will be saved on disk files. If ENTER is pressed without first choosing graphs with the SPACE BAR, no output files will be created.

The program allows changes to the file extension and to the choices of which graphs to save.

WARNING: THE PROGRAM WILL REPLACE WITHOUT WARNING FILES HAVING THE SAME NAME. Be sure of the extension before keying it!

Choosing 'QUIT WITHOUT SAVING' will terminate the program, and all output data files from the current simulation will be lost.

Input Requirements for SAMM (Data Files)

SAMM requires five input files to run a simulation. These files contain information about the following submodels:

- Geographic description of watershed
- Data on hydrology (description of stream system, individual stream characteristics, fish populations, fishing pressure, and weather data)
- Data on deer (description of deer energetics and hunting pressure)
- Description of timber management plan (logging, road building, and so forth)
- Economic values for summarizing some economic results

No file-naming conventions are required by SAMM (either root name or extension), although a system of naming data files should be established by each user so that separate scenarios and data sets are recognizable. The program prompts the user for input file names, and any legal DOS file names are allowed. Path names are not supported, so input files should reside in the same subdirectory as the SAMM executable code.

Because SAMM tracks several resources in the watershed, considerable care must be taken to assure that the five data files are describing the same watershed. If, for instance, the geographic description of the watershed specifies only one spatial unit with a stream reach running through it, then the hydrologic file must not contain any references to stream reach number 3. The program does some error checking to uncover inconsistencies in the input data. Most errors found will stop the program with an ERROR statement on the screen that requires the user to modify the input data as necessary. ERROR statements are designed to locate problem data, and in most cases the user will be informed which data item is causing the problem. Some nonfatal errors are ignored, although a warning is reported on the screen, and the program is allowed to proceed. These errors must be checked, however, as they may affect results.

There is a set of maximum limits for watershed size for SAMM input files. These limits may be changed-by a programmer if necessary, but will require a complete recompiling and linking of all FORTRAN source code and, if increased, may exceed the available memory of the computer. Watersheds smaller than these limits are totally acceptable without a modification to the program.

Default Values

The default values supplied with SAMM are:

Maximum number of spatial units in the watershed	=	30,
Maximum number of stream reaches in the watershed	=	10.
Maximum number of logging entries during simulation	=	100,
Maximum number of thinning entries during simulation	=	50.
Maximum number of road building entries	=	100 (each road entry can specify both main road and spur road mileage), and
Maximum number of deer herds in watershed	=	5.

All input data files for SAMM can be modified by using a word processor or any text editor. They are stored as text files. Care must be exercised, however, to maintain the descriptive headers that precede each data field. These headers are read as data by the program; if they are removed, the program will not execute properly.

The following sections give detailed descriptions of the major data files needed to execute SAMM.

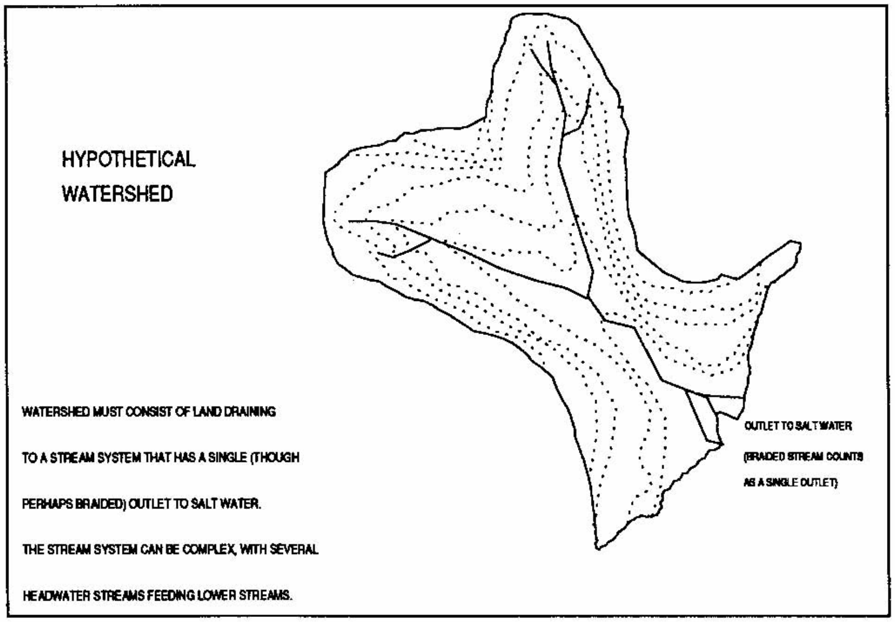


Figure 12—Map of typical watershed.

Geographic Description of Watershed[2]

The geographic description of a watershed is the basis of a SAMM run. Care must be taken to define the relations between all spatial units and all stream reaches to ensure a successful simulation. Before the geographic data file is constructed, a map of the watershed to be simulated is consulted or drawn (fig. 12). The land area characteristics, stream system morphology, and management plan for the watershed are carefully analyzed, and a plan for dividing the watershed into meaningful spatial units is devised. The watershed must be divided carefully so that spatial units are somewhat homogeneous in elevation and site characteristics and individual stream reaches consist of a single dominant stem (so that stream flow down the system will be adequately modeled). The stream reach that flows into salt water can be braided, however, as is typical in southeast Alaska. Discrete land areas and stream reaches are then delimited and numbered (as described below and as illustrated in fig. 13). This map is consulted as the data file is constructed to help visualize the geographic relations between land areas and stream reaches.

The geographic description data file has two parts: the first describes the spatial units in the watershed, and the second describes the site classes comprising each spatial unit, as described below.

The watershed is divided into a series of spatial units: each drains to a single stream reach and each is described by a single elevation (the elevation is an average for the spatial unit, and the spatial unit may in fact cover a range of elevations) (see fig. 13). Each spatial unit is then further divided into site classes, with an acreage associated with each site class. The sum of acreages for all site classes in a spatial unit is the

[2] The sample data file supplied on the SAMM diskettes is VCUDATA.TST (see appendix 3).

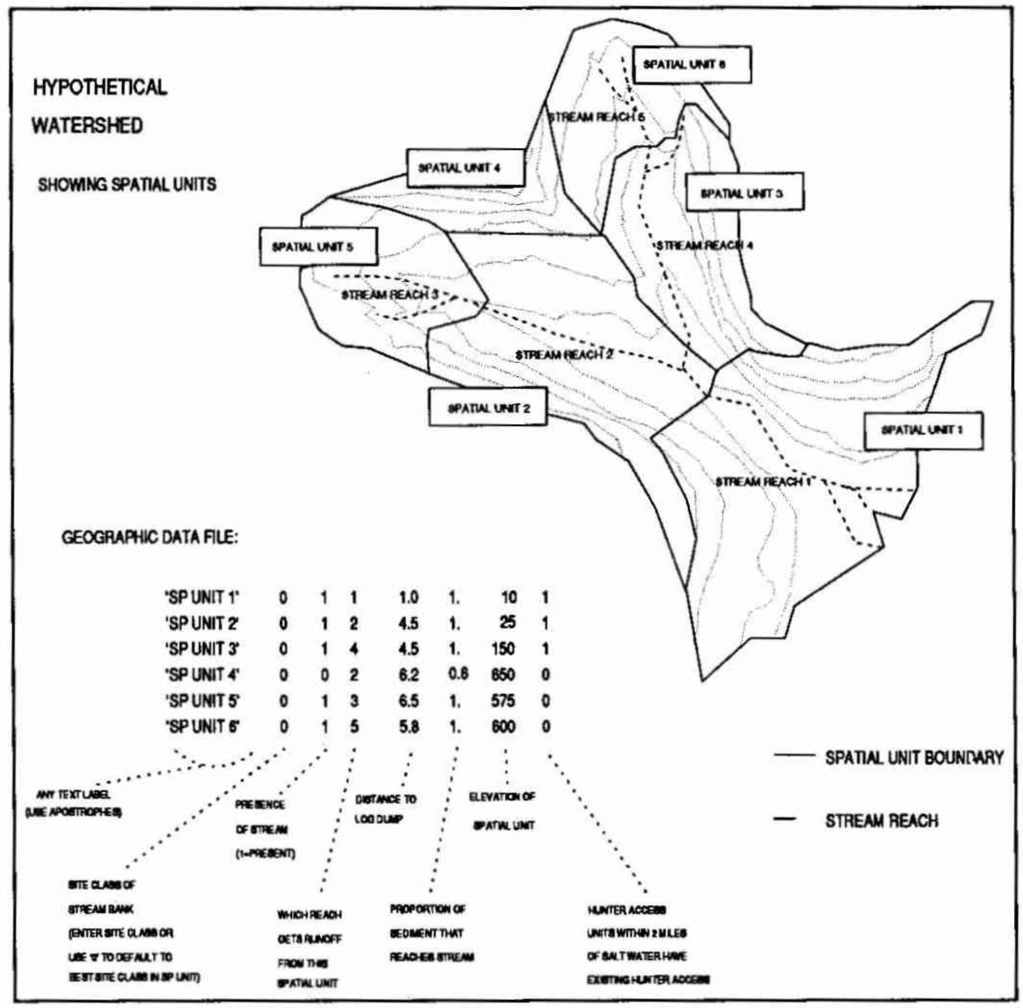
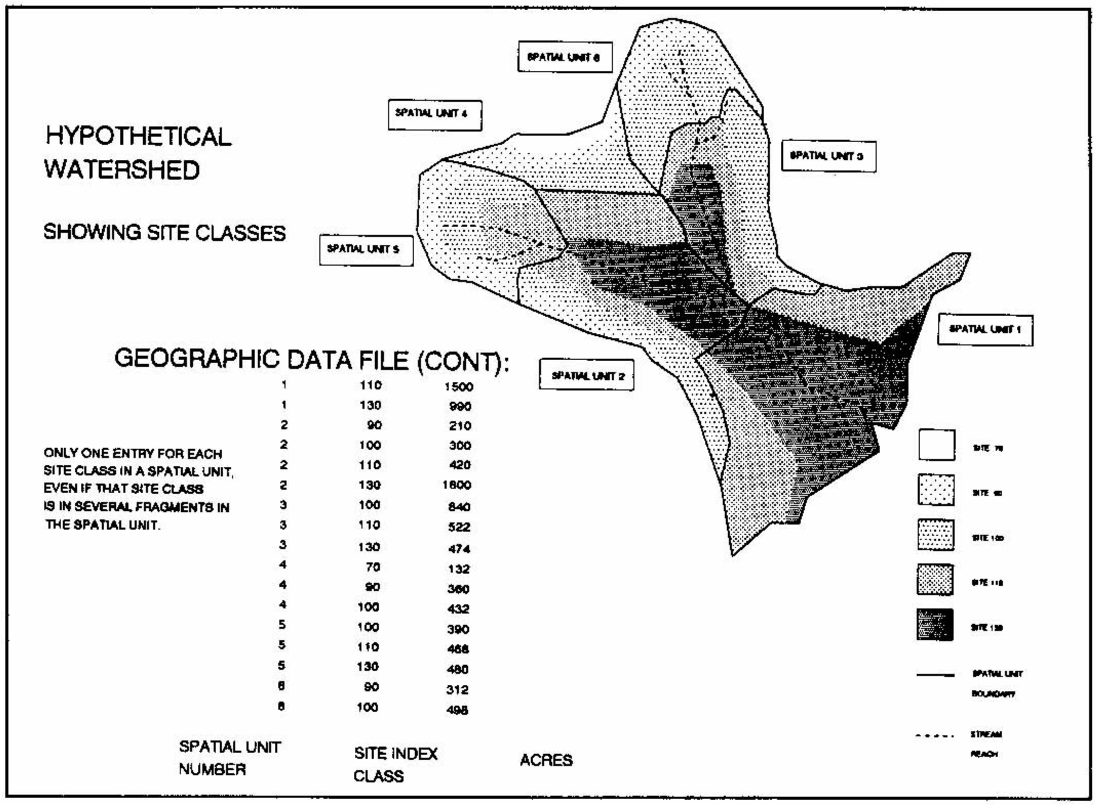


Figure 13—How to set up spatial unit and stream reach boundaries.

total acreage for the spatial unit; that is, no part of the spatial unit exists unless categorized by the site class definitions. There cannot be two acreages of the same site class in a single spatial unit; for example, all acreage of site class 90 in spatial unit 3 is treated as a continuous block (see fig. 14).

Data fields describing spatial units—Following are the data fields describing the spatial units.

Descriptive label of spatial unit—The descriptive label of the spatial unit is used only for identification, (for instance, a map reference number or a GIS cross-reference code) and is not used internally by SAMM. It is 10 characters long and must be set apart with single quotation marks.



SPATIAL UNIT NUMBER	SITE INDEX CLASS	ACRES
1	110	1500
1	130	990
2	90	210
2	100	300
2	110	420
2	130	1600
3	100	840
3	110	522
3	130	474
4	70	132
4	90	360
4	100	432
5	100	390
5	110	468
5	130	480
6	90	312
6	100	498

Figure 14—How to set up the geographic data file.

Site class bordering each stream reach—the spatial unit has a stream reach running through it, the site class bordering the stream is entered next. This must be a valid site class for the spatial unit (70-130). If a site class of 0 is entered, the program will assign the highest site class in the spatial unit to bound the stream. If there is no stream through the spatial unit, this entry should be 0.

Presence or absence of a stream reach—*An* indicator is needed to specify whether a stream reach flows through the spatial unit: '1' indicates a stream flows through the spatial unit, and '0' indicates no stream flows through the spatial unit. The program counts the number of spatial units with streams flowing through them, and this becomes the number of streams in the watershed. The hydrologic data file must not specify more than this number of streams. (If the watershed has three streams, the ocean is entered as number four.)

Stream reach receiving runoff—The number of the stream reach that will receive the runoff from a spatial unit must correspond to the stream reach number in the hydrologic data file. If a stream flows through the spatial unit (see previous data entry), then that stream receives all runoff from the spatial unit.

Distance to terminal transfer facility—The total distance in miles from the center of the spatial unit to the terminal transfer facility (typically the mouth of the watershed) is used to calculate hauling costs. The program does not calculate hauling costs based on actual miles of roads in the watershed, but instead uses this typical hauling distance to compute hauling costs. This value should be representative of the anticipated hauling distance, not distance as the crow flies.

Sediment entering a stream reach**—**The proportion of sediment (from runoff, logging, or road construction) that will reach the stream from each spatial unit is used to calculate stream sedimentation. If the spatial unit has a reach flowing through it, then this could be 1.0. If the spatial unit is separated from a stream reach by a large amount of land. then this could be set lower. As defaults, all spatial units are set to 1.0.

Elevation of the spatial unit**—**-The elevation of the spatial unit, expressed in feet, is a single representative elevation for the entire spatial unit. Elevations should be at least 1 foot.

Hunter accessibility**—**Accessibility of the spatial unit to hunters at the beginning of the simulation (those spatial units within 2 miles of salt water, or having preexisting access for hunters) is used to calculate the hunting pressure on deer. A '1' indicates the spatial: unit is accessible to hunters; '0' indicates the spatial unit is not accessible to hunters.

The second part of the geographic data file contains one line of data for each site class in each of the spatial units listed above (fig. 14). There will be one to five lines for each spatial unit in the watershed (each spatial unit must have at least one but not more that five site classes associated with it). The lines of site class information need not be in any special order; the first field will associate each line with a particular spatial unit. A line of end-data items will follow the last line of site class information. See "General Information About the SAMM Data Files" for more information on end-data.

Data fields describing site classes—Following are the data fields for each line of data describing site classes.

Spatial unit number**—**The spatial unit number corresponds to the order in which the spatial unit is listed in the data file; the first line of spatial unit data becomes spatial unit 1 and must. be referenced as spatial unit 1 in all corresponding entries describing site classes.

Site class**—**Valid entries for site class are 70, 90.100, 110, and 130.

Acres In each site class—*Acres* in each site class must be greater than 0.

Random number seed**—**If an integer between 1 and 32000 is entered, that integer will be used as the random seed. This allows the same seed to be used for several simulations, which will result in the same weather pattern each simulation. If a 0 is entered, the program will use the current time and date (based on the computer's clock and calendar) to derive a pseudorandom seed, which will vary from simulation to simulation.

It is very important that the lines of text (delimited by single quotation marks) found in the data file be maintained when the data file is modified. These lines of text are to help the user understand the various fields in the data file and are read as data by the program. If these lines are deleted or moved, the program will not run.

Hydrologic Data[3]

The hydrologic data file describes the hydrologic system in the watershed, including all stream, weather, and fisheries data. There is a line of text (delimited with single quotation marks) preceding each data field to help the user understand the data requirements. These allow the user to modify the data file with any text editor. These lines of text must not be deleted or moved, because they are read as data by the program.

The geographic description data file determines the number of stream reaches in the watershed and denotes the relation of spatial units to stream reaches (fig. 13). The data in the hydrologic data file describe each stream reach in detail.

Description of hydrologic data fields—Following are the data fields in the hydrologic data file.

Stream reach length—Length of each stream reach is expressed in meters.

Cross-sectional area—The average cross-sectional area for each stream reach is expressed in square meters. Data for each reach are separated by a blank space (or spaces).

Stream width—The average width of each stream reach is expressed in meters.

Side channel surface area—The side channel surface area serves as an additional protected area for coho salmon *(Oncorhynchus kisutch* (Walbaum)) and is not included in stream flow or temperature calculations. It is expressed in square meters.

Rubble area—Rubble area in each stream reach is expressed in square meters.

Stream reach pointers—Stream reach pointers are the stream reach numbers arranged with the headwaters stream reach number listed first and the succeeding numbers following the stream flow to the ocean (fig. 15). The program calculates stream flow, sediment transport, and water temperature by following the stream system from the headwaters to the ocean and allowing the outflow from each reach to affect the next reach downstream. For this reason, the user must delineate the order of stream reaches in the stream system, starting at the headwaters and going downstream until a branch is encountered, and then starting at the headwaters of the other fork of the branch. In this way, all inflow to a stream from all branches upstream will be accounted for when each stream reach is considered. If a stream system had the following relations (as shown in fig. 15):

Reach 1 flows into the ocean,
Reach 2 flows into reach 1,
Reach 3 is a headwater stream and flows into reach 2,
Reach 4 also flows into reach 1 but is not a headwater stream, and
Reach 5 is a headwater stream and flows into reach 4;

[3] The sample data file supplied on the SAMM diskettes is HYDRODAT.TST (see appendix 4).

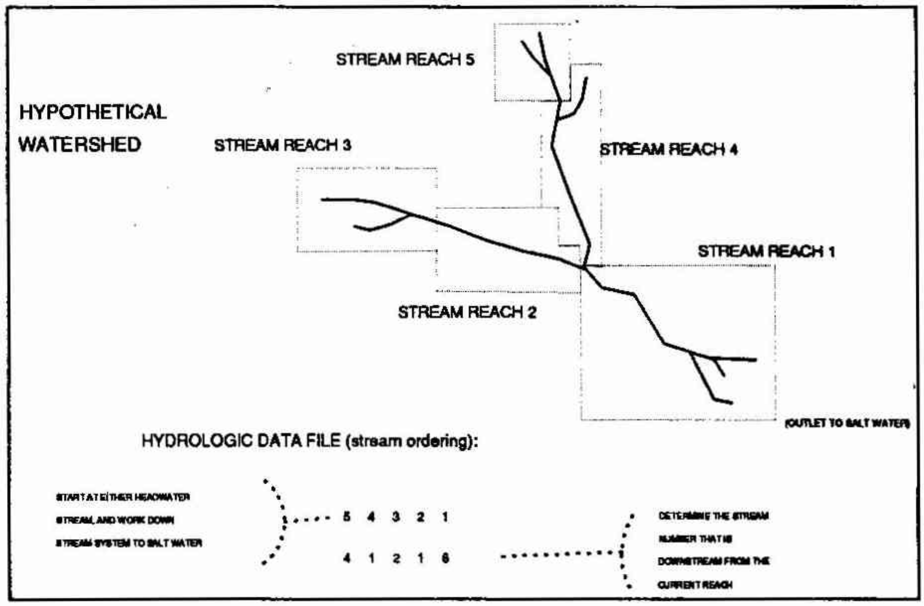


Figure 15—Assignment of stream reach numbers.

then the order of consideration of the streams would be:

5 4 3 2 1.

Because reaches 5 and 3 are both headwater (first order) streams, the order also could be:

3 2 5 4 1.

Downstream reach—-The next data item is the stream reach number of the downstream reach, from the current reach (fig.. 15). The current stream reach is determined from the order given in the preceding data, which was 5 4 3 2 1 , so the downstream reaches would be:

4 1 2 1 6;

that is, 5 flows into 4, 4 flows into 1, 3 flows into 2, 2 flows into 1, and 1 flows into the ocean. If the order of streams in the previous data item was 3 2 5 4 1 , this data field then would be:

2 1 4 1 6.

The ocean is numbered as a stream reach; it is given a number that is one greater than the number of streams in the system.

Complex stream networks can be described with this method. With a map of the watershed showing numbered stream reaches, the user traces the sediment flow down the system to determine the numbering for the data file.

Care must be taken to avoid having, for instance, stream 3 flow into stream 2, if the geographic description of the watershed shows only two spatial units with reaches passing through them. This will result in an error, and the program will stop.

The stream numbers used in this and the previous fields are the same numbers used in the geographic description data file to denote the destination of runoff sediments from a spatial unit.

Gravel area—Gravel area for spawning is expressed in square meters. There are three lines of data, each representing a fish species (pink salmon *[Oncorhynchus gorbuscha* (Walbaum)], chum salmon [0. *keta* (Walbaum)], and coho salmon). Each column corresponds to a stream reach.

Water capacity—Available water capacity of the soil for each spatial unit is expressed in inches.

Depth of undercut banks—Natural mean depth of undercut banks for each stream reach is expressed in meters. This is multiplied by the stream reach length to compute the protected area of undercut bank. This is an average depth for the entire length of the stream reach (both undercut and nonundercut banks) and does not represent the depth of a single, typical undercut bank.

Large organic debris Input—This is the amount of large organic debris that is added to the stream at the time of logging and is expressed in cubic meters of debris per meter of streambank logged. This value will be input only during the year of logging, it is a one-time pulse of debris occurring during logging.

The old-growth, or natural, input value is 0.01 cubic meters of debris per meter of streambank. If the user enters 0.02 for this data item, then each meter of streambank cut during logging will initially contribute twice the natural, old-growth amount of large organic debris. If the user inputs 0.005, then each meter of streambank cut during logging will contribute half the natural, old-growth amount. A value of 0.0 will indicate that there is no pulse of debris input at time of fogging. If the user enters a negative value, then debris will actually be removed from the stream during logging. A better way to simulate the removal of debris during logging is to activate the stream cleaning switch (see below), which will automatically remove 50 percent of the debris during logging.

Equilibrium value for large organic debris—-The equilibrium value for large organic debris is the amount of large organic debris in each stream in the absence of any management activities (in the natural, undisturbed state). This is expressed in cubic meters of large organic debris per square meter of stream surface area for each stream reach.

Equilibrium value for sediments—-The equilibrium value for sediments is the proportion of fine sediments in each stream reach in the absence of any management activities (in the natural, undisturbed state).

Fine sediments that move out each year—This is the proportion of fine sediments moving out of each stream reach each year; it affects the ratio of fine and large sediments in the stream reach. The sediments pass to the next reach downstream. The values of coarse sediments and large organic debris that move out each year are calculated in the program.

Maximum bedload shift—This is the maximum percentage of bedload shift that can occur during extreme storm events for each stream reach. A value of 0.5 would indicate that in a severe storm, a maximum of 50 percent of the stream bed would overturn (resulting in a 50-percent loss of protected area for coho and a reduction of 50 percent in fry survivability).

Edge effect of banks on stream velocity—This is the reduction in stream velocity due to the edge effect of streambanks. This will reduce the maximum stream velocity by the factor entered, thereby resulting in less bedload shift.

Stream cleaning—Stream cleaning is defined as removing 50 percent of the large organic debris in the affected stream reach at the time of logging. This value is tempered by the amount of bank cut during logging. If, for instance, 25 percent of the bank is cut and the stream-cleaning switch is set, then half of 25 percent of the large organic debris (or 12.5 percent) will be removed from the debris inventory in that stream reach. A value of 0 indicates that no stream cleaning will occur; a value of 1 indicates stream cleaning will occur at the time of logging.

First-order stream Indicator—This indicator is used to indicate all first-order stream reaches (headwater reaches) to predict debris torrents. Debris torrents occur only in first-order streams. The program does not check this indicator against the stream reach pointers (above).

Solar angle—The solar angle for the region being modeled is used to determine stream shading; it is given by month, in degrees.

Air temperature—Average sea level air temperature by month during a typical year for the region being simulated is given in °F.

Monthly precipitation—Average monthly precipitation in a typical year for the region being simulated is given in inches.

Streambank vegetation—The proportion of streambank with vegetation describes the amount of gaps in the streamside overstory vegetation. Exposed, streams in valley bottoms have more gaps in the streamside vegetation and thus have less stream shading and higher water temperatures. A value of 0.85 indicates that 15 percent of the streambank is not forested. There is one value for each stream reach.

Coho in first two age classes in fresh water—The numbers of coho in the first two age classes are used to start the program with a stable coho population. These values can be derived by using the initializer run of SAMM. The values are read from a matrix with rows being age classes and columns being stream reaches.

Number of fry—The total numbers of fry in the stream system at the beginning of the simulation are used to start the program with stable populations and are given by species (pink, chum, and coho). These values can be derived by using the initializer run of SAMM.

Ocean resident fish—The numbers of ocean resident fish at the beginning of the simulation are used to start the program with stable populations and are given by species (pink, chum, and coho). There is one age class for pinks, four age classes for chum, and one age class for coho. These values can be derived by using the initializer run of SAMM.

Precipitation-to-snow conversion factor—The number of inches of snow that is equivalent to 1 inch of precipitation is the precipitation-to-snow factor.

Temperature lapse rate—The temperature lapse rate is the decrease in temperature as a result of elevation, expressed in °F per foot of elevation above sea level.

Snow melt rate—The rate at which snow melts is expressed as the inches of water equivalent per degree-day (°F).

Standard deviation of temperature—The standard deviation of temperature sets the degree of variation in the random weather patterns. Values are for both summer and winter.

***Daily temperature* spread—The** daily spread of temperatures in summer and winter is expressed in °F. The daily range of temperatures around the mean will be plus or minus this value.

Daylight period—The proportion of daylight in a 24-hour period must be set to 0.5 for the current program.

Commercial harvest rate—The commercial harvest rate by species (pink, chum, anc coho) is the proportion of each entire spawning stock that is taken by the commercial fishery in salt water.

Ocean survival rate—The ocean survival rate is the proportion of ocean resident fish in an age class that survive each year. Values are by species (pink, chum, and coho).

Subsistence harvest—-The proportion of spawning stock taken by subsistence users in fresh water is the subsistence harvest. If a logging camp is present, this number will be modified by the program.

Sport harvest—The proportion of fish removed by sport anglers in the ocean is the sport harvest. Values are by species (pink. chum, and coho).

Vulnerability to sport catch—Fish vulnerability to sport catch is dependant on the miles of roads in the watershed (indicating sport angler access). See Fight and others (1990) for a description of this variable.

Average summer stream flows—Summer stream flows for a 100-year period are averaged to produce a typical average summer stream flow. Annual summer flows during the simulation are then compared to this average flow to calculate annual variation. Flows are calculated by stream reach and are in cubic feet per second. This variable can be calculated by using the initializer run.

Average winter stream flows—Winter stream flows for a 100-year period are averaged to produce a typical average winter stream flow. Annual winter flows during the simulation are then compared to this average flow to calculate annual variation. Flows are calculated by stream reach and are in cubic feet per second. This variable can be calculated by using the initializer run.

Freshwater fishery harvest strategy—The freshwater fishery can be regulated with two different strategies: use a 0 to indicate the mixed fishery regulations and a 1 to indicate a terminal fishery. See Fight and others (1990) for a complete description of the different strategies. This variable will not affect the saltwater component of the fishery.

Most of the variables in the hydrology data file can be entered for more stream reaches than actually exist; for instance, in a watershed with three stream reaches, the correct data for length of stream reaches might be:

```
1500 275-417.
```

But a data file having data for five reaches would work as shown in this example:

```
1500 275 417 500 265,
```

because the program will read only the first three data items. This can be useful in editing data files, because the program will read only the data for the number of reaches specified in the geographic description data file. The extra data can be stored without the program execution being affected. If, for instance, the mean depth of undercut banks for stream reaches was:

```
0.5 0.2 0.3 ,
```

then a simulation with no undercut banks could be made by changing the data to:

```
0.0 0.0 0.0 0.5 0.2 0.3 .
```

The original data are not lost and can be reconstructed easily by deleting the 0.0's.

Data for Deer Submodel[4]

The data for the deer submodel are included in a separate data file. The model allows several deer herds to occupy the same watershed, although the ranges of the various herds may not overlap. For the purposes of SAMM, each spatial unit is assigned to the range of a deer herd and must be in the range of only one deer herd. A watershed might have only one deer herd.

[4] The sample data file supplied on the SAMM diskette is DEERDATA.TST (see appendix 5).

Because deer survival is modeled by using energetics, care must be taken to ensure each herd has a winter range. Snow not only increases energetic costs but also decreases the amount of available forage. Snow depth and duration are directly related to elevation, so a herd that is not allowed a low-elevation winter range may not survive.

The user is cautioned that the deer model has several interactions among the energetics,variables listed in the deer data file. Changing certain of these variables can cause unanticipated side effects in another part of the deer model. A firm understanding of deer energetics is strongly suggested before any of these variables are altered (see Fight and others 1990).

There is a line of text (delimited with single quotation marks) preceding each data field to help the user understand the data requirements. These allow the user to modify the data file with any editor. These lines of text must not be deleted or moved, because they are read as data by the program.

Data fields in deer data file—Following are the data fields in the deer data file.

Number of deer herds In the watershed—The number of deer herds in the watershed **must** be matched with the mapping of deer herds to spatial units (below) for the program to run correctly.

Initial deer density—-The initial deer density in the watershed is expressed in deer per square mile. This value is the initial value for all herds in the watershed.

Mapping of deer herds to spatial units—The mapping of deer herds to spatial units is specified by assigning a deer herd number to each spatial unit. There will be one entry in this data record for each spatial unit in the watershed. For instance, if deer herd number 1 ranges over spatial units 1, 2, and 5, and deer herd number 2 ranges over spatial units 3, 4, and 6. then the data would be:

```
1 1 2 2 1 2.
```

Care must be taken that the herd numbers assigned to the spatial units are not greater than the number of herds in the watershed (above).

Local population of hunters—The local population of hunters is the number of full-time residents of the local area; it does not include short-duration employees, such as loggers or road builders. (The number of loggers and road builders is calculated by the program.)

Hunting days by local residents—The hunting days by local residents are specified as the average number of hunting days per year per local resident hunter. The local population of hunters (above) is multiplied by this number to calculate total local hunting pressure, excluding loggers and road builders.

Proportion of loggers and road builders that hunt—The proportion of loggers and road builders that hunt is used to determine the added hunting pressure resulting from logging or road building in the watershed. Logging and road building employment levels are calculated by the program, and this proportion reduces the total number of employees to account for the proportion that do not hunt.

Hunting days by loggers or road builders that hunt—The hunting days by loggers and road builders that hunt are specified as the average number of hunting days per year per employee that hunts. The total number of employees (hunters and road builders) that hunt is multiplied by this variable to determine total hunting pressure from loggers and road builders.

Maximum hunter days from outside the watershed—The maximum hunter days from outside the watershed is the maximum possible hunting pressure from nonlocal residents and is measured in total hunter days. This level of hunting pressure is achieved only when hunting success is the highest.

Gross energy equivalents for forage—The gross energy equivalent is the gross energy in each forage class in each season, measured in kilocalories per kilogram of forage. The values are read from a matrix with rows being summer and winter and columns being forbs, shrubs, and lichens.

Digestibility factor—-The digestibility factor accounts for the variation in forage quality between open and forested sites for each forage class in each season, as measured in the percentage of gross energy (above). The values are read from a matrix with rows being summer and winter and columns being forbs, shrubs, and lichens. The digestibility factor reduces the gross energy to yield digestible energy.

Metabolizable energy factor—The metabolizable energy factor accounts for the amount of digestible energy lost to urine production and thus is not available for deer maintenance and growth. This adjustment is a percentage of total digestable energy and apply's to all forage classes and seasons.

Body weight of deer—The body weight of deer is measured in kilograms. The values are read from a matrix with rows being fawns and adults and columns being summer and winter.

Energy per kilogram of body weight—The energy per kilogram of body weight is the average kilocalories of energy found in each kilogram of protein and fat, weighted by the percentage occurrence of protein and fat in deer. This value is measured in kilocalories of energy per kilogram of body weight and is used to calculate energy reserves.

Net energy coefficient—The net energy coefficient adjusts the energy available to deer to account for the energy loss from heat of nutrient metabolism. This value is measured as the percentage of available digestible energy after adjustment for energy loss.

Active metabolic rate factor—-The active metabolic rate factor is an adjustment to the basal metabolic rate for deer to account for the higher metabolic rates resulting from deer activity; it generally is in the range of 1.25 to 2.00. The value is read from a matrix with rows being summer and winter and columns being fawns and adults.

Handling times modifier—The handling times modifier is a global adjustment for handling times (below). This variable was used for model calibration and should not be changed.

Handling time—Handling time is the reciprocal of forage intake rate, and is measured in days per kilogram of forage by forage class, season, and deer group (fawns and adults). The values are read from a matrix formatted as shown by the sample data in the following tabulation:

			Forage class	
Deer group	**Season**	**Forbs**	**Shrubs**	**Lichens**
Fawns	Summer	0.40	0.60	0.40
	Winter	.45	.80	.50
Adults	Summer	.30	.50	.30
	Winter	.40	.60	.40

Forage class preference factor—Vine forage class preference factor is-based on subjective observations of deer feeding behavior. The values are read from a matrix with rows being summer and winter and columns being forbs, shrubs, and lichens. This is a highly sensitive variable and should not be changed from the preset values.

Search rate—The rate at which deer search for forage is expressed in days per hectare searched, with values for both fawns and adults.

Survival rates—Maximum survival rates are expressed as a percentage for fawns and adults.

Fawning rate—The fawning rate is the number of fawns per adult deer. This is given per deer; for example, a value of 0.75 fawns per deer would be equivalent to 1.5 fawns per doe.

***Metabolic costs for* snow—**The added metabolic costs for moving through snow are given by snow depth classes (under 2 inches, 2-20 inches, over 20 inches). The values are read from a matrix, with rows being fawns and adults, and columns being depth classes.

Forb carrying capacities—Maximum forb carrying capacities are given for site classes 70 and 130; the program will calculate forb carrying capacities for the intermediate site classes.

Shrub carrying capacities—Maximum shrub carrying capacities are given for site classes 70 and 130; the program will calculate shrub carrying capacities for the intermediate site classes.

***Net energy gain**—The* maximum net energy gain is not currently used by the program; it is for a deer allocation scheme that is under development. A dummy value (0.00) must be given, however, for the program to execute properly.

***Output level for printouts*—**The output level is used for debugging the model and should not be set under 10.

Description of Management Plan[5]

The SAMM management plan is specified in four separate parts:

1. Logging harvest (clearcut of old growth).
2. Road building.
3. Precommercial and commercial thinning.
4. Site preparation and planting.

The first three management scenarios affect the other parts of the model through canopy cover, sedimentation of streams, and so forth. The fourth scenario includes associated costs for site preparation and planting and is for economic analysis only. Site preparation and planting will not affect the growth rates of timber or the later value of timber or any other resource. The first three scenarios also have associated economic implications. The program does not allow for subsequent harvest of second-growth timber.

Management data in SAMM is delimited with the end-data value to indicate to the program that a certain type of data is complete. End-data in SAMM is value -99; it must be placed in each data field and be read as data. The use of end-data eliminates the need to count data records in an input file. See "General Information About the SAMM Data Files" for more information on end data.

Specifying SAMM logging data—The data required to carry out the simulated timber harvest must be specified as shown below.

Two types of logging plans can be used in SAMM. The first allocates the harvest acreage proportionally to occurrence of site classes in the spatial unit. If, for instance, 25 percent of the spatial unit is site 90 and 75 percent is site 110. then 25 percent of the logging acreage will be taken from site 90 and 75 percent from site 110. This allows for a simple data file but is not descriptive of a typical logging plan.

The second method allocates harvest acreage site by site, with the user entering the actual acres for each site in the spatial unit for each logging entry. This requires a more detailed data file than the first method but is more descriptive of a typical logging plan.

Both plans allow for entering a percentage of the streambank to be cut and specification of the harvest method used.

[5] The sample data file supplied with the SAMM diskettes is PLANDET.TST (see appendix 6).

Following is a description of each field in the SAMM logging data:

Harvest acreage allocation switch—The harvest acreage allocation switch indicates which scheme will be used in allocating acreage for harvest; 0 is the proportional acreage allocation, 1 is the hard acreage allocation. This item is followed on the same line by a character variable (set off with single quotation marks) that helps to describe the following six data items below, which are included for each logging entry.

A separate line of data is included in the data file for each logging entry that will be carried out in the management plan. After all logging entries are entered, end-data items are listed for each field.

1. Year of logging entry. The year of logging entry is the number of years since the beginning of the simulation within which an entry is to occur; for instance, a value of 35 would indicate that the logging entry would occur after SAMM has simulated 34 years in the current run. Use 999 (or any other year beyond the duration of the simulation) to ignore a line of data during the current simulation.

2. Spatial unit in which the logging entry occurs. If a management plan will specify logging in several spatial units in the same year, a separate line must be entered for each spatial unit.

3. Harvest acreage for proportional allocation. This value is the total number of acres to be harvested if the proportional allocation scheme is selected (see above). The acreage specified here will be proportionately allocated for harvest based on the relative acreage in each site class in the spatial unit. If the hard acreage allocation scheme is chosen (see above), this field will be read and then ignored. Even with hard acreage allocation, a data item must be entered for this field (for example, 0).

4. Harvest method to be used in this logging entry. Each harvest method has associated costs (see "Economic Data") that will affect total harvest costs depending on the site class being harvested. Harvest methods will not affect any other variables. The harvest method specified corresponds to a column of data in the economics data file.

5. Percentage of streambank that will be cut in this logging entry. The percentage of streambank to cut is based on the total streambank length for the stream reach, including both banks of the stream. For instance, if a stream reach is 1000 meters long and this variable specifies a 30-percent bank cut, then 30-percent of 2000 meters will be cut. The program will check for cut streambanks specified in spatial units having no streams running through them and for cut streambanks specified in site classes not adjacent to the stream. Either condition will stop the program.

6. Harvest acreage for hard acreage allocation scheme. The next five fields are the acres by site class that will be harvested in this logging entry if the hard acreage allocation scheme is chosen (see above). The first field is the acres to cut in site 70, next is the acres to cut in site 90, and so on through sites 100,110, and 130. Site 70

is noncommercial forest type and typically always will be zero. The program checks to make sure acreage exists in a specified site class in the spatial unit and checks that the acreage allocated to harvest is not greater than the existing acreage. Either condition will stop the program with an error statement.

If the hard acreage allocation scheme is chosen, all five fields (one for each site class) must have a value for each logging entry in the management plan. To harvest, for example, 30 acres of site class 100 and 50 acres of site class 130. the five fields would be entered as 0.0 0.0 30.0 0.0 50.0 . Fractional acreage is allowed, and the minimum specified harvest in any site class is 0.1 acre. Even if the spatial unit has no acreage in sites 70, 90, and 110, a 0.0 must be entered. If the proportional acreage allocation scheme is chosen, these fields are ignored by the program (and can be left blank).

Both allocation schemes will use the same year, spatial unit, harvest method, and amount of bank cut.

Specifying SAMM road building date—The data necessary to carry out the simulated road building in SAMM must be specified as shown below.

There are two types of roads in SAMM: main haul roads and spur roads. The construction of roads is not required for timber harvest simulation, so the user is expected to track that the necessary roads are scheduled as timely. Road building can occur in years without timber harvest, and timber harvest can occur in years without road building. Main haul roads can be constructed in years without construction of spur roads, and spur roads can be constructed in years without main haul roads. After all road building entries are entered, end-data markers must be placed in each field.

Descriptions of the data fields in the road building plan follow.

Year—The year in which road building is to take place is entered. If roads are to be built in several spatial units in the same year, each spatial unit will require a separate line. Main haul roads and spur roads built in the same spatial unit in the same year can be specified with a single line of data.

Spatial unit—The spatial unit in which the road building is to take place is specified. If a road is built through several spatial units, each spatial unit is entered on a separate line.

Miles of main road—The miles of main road is the total number of miles of main road built in the specified spatial unit in the specified year.

Miles of spur road—Miles of spur road is the total number of miles of spur road built in the specified spatial unit in the specified year.

Note the line of end-data markers at the end of the road specifications.

Specifying SAMM precommerclal and commercial thinning data—The data necessary to carry out the simulated timber thinning in SAMM must be specified as shown below.

Thinning occurs across site classes and is based on the age class of the stand. A thinning could specify, for example, that all timber of age class 4 (31 to 40 years old) in spatial unit 3 will be thinned. All site classes from the spatial unit that was logged 31 to 40 years earlier in the simulation will be thinned as one entry.

Description of the data fields in the thinning plan follows.

Year—The year when the thinning entry is to take place is entered. If thinning is to occur in several spatial units in the same year, each spatial unit will require a separate line. Similarly, if several age classes are to be thinned in the same spatial unit in a certain year, each age class will require a separate line.

Residual basal area—The residual basal area to be left after thinning is expressed in square feet (at breast height) per acre. If the basal area at the time of thinning is less than the residual basal area to be left after thinning, the program will ignore the thinning entry without any error statement.

Spatial unit—The spatial unit number in which the thinning is to occur is specified.

Age class—The age class of timber to be thinned during this entry is specified as the number of years from the time of original harvest, with age class 1 equal to 1 to 10 years, age class 2 equal to 11 to 20 years, and so forth. ,If none of the stand is of the proper age class, the thinning entry will be ignored without a warning statement. Because there is no warning, care must be taken in designing the input data so that the age classes are entered correctly for the desired thinning to occur. All stands in the spatial unit with timber in the specified age class will be thinned.

Harvest method—Each harvest method has associated costs (see "Economic Data") that will affect total harvest costs depending on the site class being harvested. Harvest methods will not affect any other variables. The harvest method specified corresponds to a column of data in the economics data file.

Economic Data[6]

The economic data file includes the data required for the economic calculations in SAMM.

Discount rates—The user can enter three different discount rates. Some of the graphs will use all three rates in comparison, but the first rate of the three is used exclusively for most outputs. Rates range from 0.0 to 1.0.

Site preparation costs—Site preparation costs include costs for site preparation, planting, and any precommercial thinnings not covered by the thinning plan and are expressed in dollars per acre. Costs for commercial thinnings are calculated in the harvest routines.

[6] The sample data file supplied with the SAMM diskettes is ECON.DAT (see appendix 7).

Associated harvest costs—Associated costs of harvest include sale layout and planning, sale administration, environmental protection, hauling from terminal transfer facility to the sawmill, and any other costs not included in specific data items. Costs are expressed in dollars per thousand board feet harvested.

Wood hauling costs—Wood hauling costs are the costs per mile for transport of harvested material from the logging site to the terminal transfer facility. The mileage from each spatial unit to the terminal transfer facility is entered in the geographic data file; it is not based on the number of miles of road built in the watershed. Costs are expressed in dollars per thousand board feet of harvested material per mile hauled.

Road maintenance costs—Road maintenance costs are expressed in dollars per thousand board feet of harvested material per mile of road. This cost is based on the total number of miles of road in the spatial unit being logged.

Mainline road construction costs—The costs per mile for mainline road construction are expressed in dollars per mile of main line road built in the current year.

Spurline road construction costs—The costs per mile for spur road construction are expressed in dollars per mile of spur road built in the current year.

Value of cedar—The value of cedar is given in dollars per thousand board feet. Even though cedar is not presently modeled in SAMM, a value (for example, 0.0) must be entered in this field.

Value of wood by volume class—The value of wood by volume class is given in dollars per thousand board feet: The volume classes are 0-8, 8-20, 20-30, 30-50, and greater than 50 (volume class values are in thousands of board feet per acre).

Value of commercially thinned material—The value of commercially thinned material is given in dollars per thousand board feet harvested. This value applies to all commercially thinned material regardless of diameter.

Harvest costs—Harvest costs are given in dollars per thousand board feet of harvested material and vary by site class harvested and harvest method used. Typical costs for various harvest methods are listed in Fight and others (1990). Harvest costs are listed in the data file with rows being site classes and columns being harvest methods.

Acres harvested per mile of road for each harvest type—These values are not used currently but must be present in the data file.

Employment rate—The employment rate is given for each of the following employment catagories: timber harvesting (expressed in person years per thousand board feet harvested), road building (expressed in person years per mile of road built), timber thinning (expressed in person years per thousand board feet thinned), and site preparation (expressed in person years per acre treated with site preparation).

Employment during hunting season—The proportion of total annual employment that takes place during the hunting season is specified for the following employment catagories: timber harvesting, road building, timber thinning, and site preparation.

Advanced Topics

Initializer Run

The fisheries model requires long-term average values for fish populations and stream temperature that are based on the stream morphology described in the data set. The only way to derive these values; is to run SAMM for 100 years, average the populations and temperatures, and put the averages into the data file for subsequent runs. The initializer run makes a 100-year simulation from the estimated values for fish populations and long-term stream temperatures found in the input file. The initializer run calculates the correct initial values for these variables for subsequent runs, and writes those values in a file named 'GRAFS\RUNSPECS'. *These values must be moved into the hydrology input data file by the user before subsequent simulations are done.*

The importance of the initializer run is that it allows the fish population and stream temperature to stabilize in the stream system for 100 years and then uses those stable values as initial values for subsequent runs. Any time the stream morphology as described in the input data is changed, the initializer run should be used and the data file edited. Changes in any of the following stream characteristics will affect either fish populations or stream temperatures and will indicate use of the initializer run:

- Stream length, width, or cross section
- Site class of streamside spatial units
- Amount of openings along streambank
- Solar angles
- Depth of undercut banks
- Amount of gravel, rubble, and side channel area

The initializer run takes as long as a 100-year simulation, so be judicious in using it.

If the initializer run has been used and the fish populations still are not stable (or are nonexistent), further runs of the initializer run may be necessary. The first time it is run, new long-term stream flows are calculated. Use these values at the beginning of the next initializer run. In some cases, stream morphology will not be adequate to sustain viable fish populations.

Saving Run Parameters

The run parameters, including input data file names, management options (whether or not logging is allowed, whether or not deer hunting is allowed, and so forth), and the choices for run-time graphs are stored by SAMM in a tile named DEFAULTS. This file is updated each run and contains the default values for the next run.

The DEFAULTS file can be used to manage multiple data sets in the following way. If SAMM is run with a large data set (for instance, the data from a large, complex watershed in southeast Alaska) and several hypothetical data sets for looking at variables in a controlled environment, then the DEFAULTS file for each data set can be copied to a file with a different name and saved for later. To run the data from the actual watershed, delete the current DEFAULTS file, copy the saved data file for the watershed (for example, DEFAULTS.SEA) to DEFAULTS, and run the program. The data file names will be loaded as defaults into the program, along with the run parameters used the last time a simulation was run from the watershed data. This saves having to edit the file names in the program.

Output File Names

A system for naming output files should be designed that will keep track of the run parameters used to generate each file. Output files from SAMM are named with the graph number and a user-specified extension; either the file can be renamed externally to SAMM, or a file extension of three numbers or three letters can be used. Output from several runs then can be compared on a single graph by using a package such as Lotus 1-2-3 (to get the output files into Lotus, enter the following Lotus commands: / File Import Numbers [enter the file name including path and extension]). Several files can be imported to the same worksheet and plotted on the same graph.

Correlation of Graphs to Data

Some of the output data files contain several columns of data, which can lead to confusion when columns of data with specific variables are correlated. Columns of output data are correlated to variables as follows.

Deer herd numbers—The number of deer herds in the watershed determines the number of columns in deer data output files. The columns of data correspond to the herd numbers entered by the user in the deer input data (where the herds are mapped to spatial units). The first column corresponds to the herd numbered 1, the second column to the herd numbered 2, and so forth.

Stream reach numbers—Stream reach numbers correspond to the reach numbers entered in the geographic data file. The first column corresponds to the stream reach numbered 1, the second column to the stream reach numbered 2, and so forth.

Species of fish—The first column of output data corresponds to pink salmon, the second column corresponds to chum salmon, and the third column corresponds to coho salmon.

Two Simulations From One SAMM Run

Data files can be set up to simulate two runs with a single SAMM simulation. If, for example, the effects of logging on deer for a 5-spatial-unit watershed are being studied, then a geographic description data file with 10 spatial units should be designed, with the second 5 being identical to the first 5. Also define the site class information similarly. Design the logging plan data file to harvest timber only in spatial units 1-5. Map deer herd 1 to spatial units 1-5 and deer herd 2 to spatial units 6-10. When the logging plan is activated, deer herd 1 will show the effects of logging, and deer herd 2 will show the control or no-logging scenario. Both herds will be printed on the same graph as the program runs. This method can be used to run five herds on ranges that differ only by site class or that differ with elevation.

Because there is only a single fish population for the watershed, this method cannot be used for fishery simulations.

Changing Data File Names

It is usually easier to edit the DEFAULTS file with a text editor or word processor than with the interactive CHANGE FILE NAMES part of the program. The program is admittedly weak on editing facilities for file names, and a recurring error sometimes makes it impossible to change the file names. Simply edit the DEFAULTS file the same as a data file, put in the new data file names, change the parameters if necessary, and even choose different run-time graphs. Be sure to preserve the single quotation marks that surround the file names in DEFAULTS:

Running SAMM From a RAM Disk

The program creates a temporary file during each simulation that is used to store intermediate results of several variables for each year of the simulation. This slows the program considerably, particularly if the computer has a slow hard disk or if the program is being run from a floppy disk.

A RAM disk can be employed effectively to circumvent this problem. The following command needs to be added to the CONFIG.SYS file used by the computer:

```
DEVICE=VDISK.SYS 135 .
```

This will create a 135K byte RAM disk (also called a virtual disk) that should be adequate to run SAMM. The computer will need to be turned off and back on after the above command is added to the CONFIG.SYS file. Every time the computer is turned on after the command is added, the RAM disk will be activated and will be available for SAMM simulations or any other software that can make use of a RAM disk. A file named VDISK.SYS, supplied with the computer operating system, must be in the boot directory for the computer to use a RAM disk (the boot directory is the directory containing the COMMAND.COM file, whether on a hard disk or a floppy disk system). See operating system documentation supplied with the computer for more information on RAM disks.

If the computer has one floppy disk and a hard disk with two partitions (C and D), then the RAM disk will be labeled as drive E. Simply copy the following files to drive E (or whichever drive letter is the RAM disk):

```
DEFAULTS
ALL INPUT DATA FILES NEEDED
ROMANSIM.FNT
```

Create a subdirectory on drive E named GRAFS. Start SAMM by entering the full MS-DOS path to the SAMM files; for instance, D:\SAMMDIR\SAMM . SAMM will execute normally (be sure to run METAWNDO the first time), and all output will be saved into the subdirectory E:\GRAFS. These output data files will be lost when the computer is shut off, so be sure to copy them from the RAM disk to the hard disk before shutting off the computer.

Possible Errors

A listing follows of several problems that may be encountered when using SAMM, and possible solutions to each problem.

Error: Pressing SHIFT-PRTSCRN does not result in a graph being printed.

Solutions:
Make sure that the printer is connected to the computer and that it is turned on.

Be sure to enter PRTSCRN before running SAMM to invoke the screen print driver.

Enter MODE LPT1 before running SAMM to make sure that the printer is connected to the default printer port.

Turn the printer off and then back on to reset it to default settings. Only Epson FX series and the IBM Proprinter are supported. Many other dot-matrix printers emulate the Epson standard and should work.

Error: Printed graphs are compressed to only half a page.

Solutions:
The printer is not fully emulating Epson FX series printers.

The printer is configured for compressed print; turn the printer off and then back on to set it to default settings.

The screen print facility does not use the full width of the paper even with an Epson printer. This is a limitation of the screen dump facility being used. To get high-quality printed copies of graphs, save the data needed to draw the graphs, and print the graphs with a commercial graphics package.

Error: After SAMM is entered, the following message is received: 'ERROR METAWNDO not installed'.

Solution:
Enter METAWNDO before running SAMM. METAWNDO is supplied with the SAMM diskette. It must be in the SAMM subdirectory or in a subdirectory that can be reached with a path command.

Error: After SAMM runs, the computer is in 40-column text mode.

Solutions:
Make sure that all the font files (files with an extension of .fnt) are in the SAMM subdirectory; they are needed to restore the system screen font.

If the computer is in 40-column text mode, or 80-column graphics mode after SAMM execution, enter MODE BW80, MODE C080, or MODE MONO to return to 80 columns.

Error: An error stops SAMM, and keyboarded commands are overwriting the graphs on the screen.

Solutions:
There is probably no way to save the on-screen graphs. To remove the graphics clutter from the screen, enter CLS. Follow with one of the MODE commands (see above) if necessary.

Some error messages may be written to the screen as text during a simulation, and will scroll the graphs out of view from the screen. Often these messages are warnings and will only cause a pause in the simulation. In this case, make a note of the error message and press ENTER to resume the SAMM simulation. The run-time graphs will be ruined, but once the simulation is finished any of the graphs can be recalled for inspection. If the error message is fatal, the program will stop, and all data will be lost. Correct the data file per the suggestions in the error message before rerunning SAMM.

Error: Arrow keys do not move the highlighted box on the screen.

Solution:
Some computers with dedicated cursor (arrow) keys will require the use of the arrow keys on the numeric key pad. Be sure that NUM LOCK is off in order to use the arrow keys.

Error: Mouse device does not move the highlighted box on the screen.

Solution:
Mouse devices are not supported by SAMM at present.

Error: Colors are not displayed on color monitor.

Solution:
SAMM uses a graphics package that senses the type of graphics card in use in each computer. Most graphics cards are supported; however, if the software does not recognize the graphics card in use, it may default to monochrome mode.

Error: Colors used in graphs are hard to tell apart or are the same as the background color,

Solution:
SAMM is distributed with a separate program called SETCOLOR. Run this program and choose the desired colors for background and lines from those available.

Error: Program runs up to the main graph menu, then locks up.

Solution:
Some very high resolution monitors may require more memory to store the background image than has been allowed for in the program. Try to reconfigure the graphics card to emulate EGA or Hercules graphics.

Error: 'ERROR 1008' message scrolls up screen continually.

Solutions:
This is a run-time FORTRAN error message indicating that an argument to an EXP function has gone out of range or is undefined. This is usually caused by specifying fewer deer herds in the DEER DATA file than have been assigned to spatial units. For instance, if there are five spatial units, and two herds have been specified at the beginning of the deer data, then when the following assignment of herds to spatial units is done:

1 2 2 3 1 ,

deer herd 3 will be undefined, and ERROR 1008 will scroll up the screen. Enter CONTROL-BREAK at the same time to stop SAMM, edit the deer data, and restart the program. If CONTROL-BREAK does not work, press the CONTROL, ALT, and DELETE keys simultaneously to restart the computer.

Error: 'ERROR 3012' is printed on the screen and the program stops.

Solutions:
This is a FORTRAN error message, indicating that the program was unable to find file DEFAULTS, or the specified data file names, or subdirectory GRAFS. Be sure that all files necessary to run SAMM are in the proper directory and that a sub-directory named GRAFS has been created.

This message also will be encountered when there is an error in an input data file and SAMM tries to read past the end of the file.

Other '3000' series error messages usually will be caused by MS-DOS being unable to find a file name or by an error in writing to or reading from a file. Be sure there is enough room on the disk for output files, because there is no error message to indicate that no more space is available. Once the disk is full, the program will display a '3000' series message indicating a formatted write error.

The distribution version of SAMM is compiled with the Ryan-McFarland FORTRAN compiler, and any FORTRAN error messages can be found in the Ryan-McFarland manual.

For other errors or to make suggestions, call, write, or send a message on the Forest Service communications network to:

Dale Weyermann
Forestry Sciences Laboratory
Pacific Northwest Research Station
P.O. Box 3890
Portland, OR 97208-3890

(503)321-5903

Data General address: D.WEYERMANN:S26L07A

Literature Cited

Fight, Roger D.; Garrett, Lawrence D.; Weyermann, Dale L., tech. eds. 1990. SAMM: a prototype southeast Alaska multiresource model. Gen. Tech. Rep. PNW-GTR-255. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 109 p.

Appendix 1

A List of Graphs With Associated File Names

No.	Filename[1]	Graph menu title
1	GRAPH0I.xxx	WATERSHED VOL(MMBF)
2	GRAPH02.xxx	OLD GROWTH ACRES
3	GRAPH03.xxx	VOLUME CUT
4	GRAPH04.xxx	MAIN:SPUR ROAD MI
5	GRAPH05.xxx	EMPLOYMENT
6	GRAPH06.XXX	SPAWNERS
7	GRAPH07.XXX	FRY (BY SPECIES)
8	GRAPHO8.XXX	COMMERCIAL CATCH
9	GRAPH09.XXX	SPORT CATCH (CPUE)
10	GRAPHI0.xxx	PERSONAL USE CATCH
11	GRAPHH.XXX	PERCENT FINE SEDIMENT
12	GRAPH12.XXX	LARGE ORG DEBRIS INV
13	GRAPH13.XXX	STREAM TEMP (SUMMER)
14	GRAPH14.XXX	EFF BANK CANOPY
15	GRAPH15.xxx	PERCENT PROTECTED
16	GRAPH16-xxx	DEER DENSITY BY HERD
17	GRAPH17.XXX	HUNTING HARVEST
18	GRAPH18.xxx	SURVIVAL RATE ADULTS
19	GRAPH19.xxx	SURVIVAL RATE FAWNS
20	GRAPH20.XXX	TOTAL YEARLY SNOWFALL
21	GRAPH21.XXX	DEEPEST SNOW
22	GRAPH22.XXX	UNDERCUT BANK AREA
23	GRAPH23.XXX	PRES NET WORTH(TIMBER)
24	GRAPH24.XXX	(available)
25	GRAPH25.XXX	HARVEST BY SITE CLASS
26	GRAPH26.XXX	PINK COMM:PERSONAL USE
27	GRAPH27.XXX	CHUM COMM:PERSONAL USE
28	GRAPH28.XXX	COHO COMM:PERS:SPORT
29	GRAPH29.XXX	STREAM VELOCITY(M/SEC)
30	GRAPH30.XXX	HUNTING EFFORT
31	GRAPH31.XXX	KILL PER EFFORT
32	GRAPH32.XXX	COHO/SQ-M BY YEAR CLASS
33	GRAPH33.XXX	SMOLT BY YEAR CLASS
34	GRAPH34.XXX	BEDLOAD SHIFT PROBABIL
35	GRAPH35.XXX	SUMMER LOW FLOW FACTOR
36	GRAPH36.XXX	WINTER LOW FLOW FACTOR
37	GRAPH37.XXX	(available)
38	GRAPH38.XXX	(available)
39	GRAPH39.XXX	SAVE OUTPUT, THEN QUIT
40	GRAPH40.XXX	QUIT WITHOUT SAVING

[1] The file extension .xxx is user-specified and should conform to an overall user-designed file-naming convention.

Appendix 2

Brief Description of Each Graph

1. WATERSHED VOL(MMBF)—This graph has three lines showing volume of old-growth timber in the watershed/volume of young-growth timber in the watershed, and total timber volume in watershed (sum of the other two values). Volumes are shown in millions of board feet.

2. OLD GROWTH ACRES—This graph shows the number of acres in the watershed remaining as old growth.

3. VOLUME CUT—This graph shows the total volume of timber harvested in the watershed in each year in thousands of board feet. This is not cumulative from year to year.

4. MAIN: SPUR ROAD MI—This graph has two lines showing total miles of main road and total miles of spur road in the watershed. Spur roads are not retired in this model.

5. EMPLOYMENT—This graph shows total employment in the watershed from loggers and road builders in person years.

6. SPAWNERS—This graph has three lines showing the total number of returning pink, chum. and coho salmon. Because the number of pink and chum is much greater than the number of coho in a typical watershed, the coho line may appear to be zero. Several other graphs allow the coho population dynamics to be studied without this scaling problem.

7. FRY (BY SPECIES)—This graph has three lines showing the total number of fry produced for pink, chum, and coho salmon. Because the number of pink and chum is much greater than the number of coho in a typical watershed, the coho line may appear to be zero. Several other graphs allow the coho population dynamics to be studied without this scaling problem.

8. COMMERCIAL CATCH—This graph has three lines showing the total number of pink, chum, and coho salmon that are commercially harvested. Because the number of pink and chum are much greater than the number of coho in a typical watershed, the coho line may appear to be zero. Several other graphs allow the coho population dynamics to be studied without this scaling problem.

9. SPORT CATCH (CPUE)-This graph has a single line showing the sport fishing success in terms of catch per unit of effort (one unit of effort is equal to one angler day). Coho is the only species harvested by sport fishermen.

10. PERSONAL USE CATCH—This graph has three lines showing the total number of pink, chum, and coho salmon taken by personal-use harvest. Personal-use harvest is the allowable harvest taken by local Native populations. Because the number of pink and chum is much greater than the number of coho in a typical watershed, the coho line may appear to be zero. Several other graphs allow the coho population dynamics to be studied without this scaling problem.

11. PERCENT FINE SEDIMENT—This graph will have a separate line for each stream in the watershed. The value graphed is the percentage of sediment that is fines (less than 3 millimeters in greatest dimension). This is NOT the inventory of fine sediment in each stream reach.

12. LARGE ORG DEBRIS INV—This graph will have a separate line for each stream in the watershed. The value graphed is the inventory of large debris found in each stream reach in cubic meters of debris per square meter of stream surface area.

13. STREAM TEMP (SUMMER)—This graph will have a separate line for each stream in the watershed. The value graphed is the maximum summer stream temperature for each stream reach in °C.

14. EFF BANK CANOPY—This graph will have a separate line for each stream in the watershed. The value graphed is the percentage of streambank that has canopy closure along it. Each line represents an average for the entire stream reach.

15. PERCENT PROTECTED—This graph will have a separate line for each stream in the watershed. The value graphed is the percentage of total stream area that is considered protected area for fish (undercut banks, rubble areas, pools, or side channels).

16. DEER DENSITY BY HERD—This graph will have one line for each deer herd in the watershed. The value graphed is the number of deer per square mile in each herd.

17. HUNTING HARVEST—This graph will have one line showing the total hunting harvest of deer in the watershed.

18. SURVIVAL RATE ADULTS—This graph will have one line for each deer herd in the watershed. The value graphed is the survival rate of adult deer in each herd.

19. SURVIVAL RATE FAWNS—This graph will have one line for each deer herd in the watershed. The value graphed is the survival rate of fawns in each herd.

20. TOTAL YEARLY SNOWFALL—This graph has one line that is the total number of inches of snow that fall each year in a forest opening (not intercepted by canopy) in spatial unit number 1. The value graphed will be the snowfall at the elevation of spatial unit 1.

21. DEEPEST SNOW—This graph has one line that is the deepest accumulation of snow (in inches) in a forest opening (not intercepted by canopy) in spatial unit number 1 each year. The value graphed will be the deepest accumulation of snow at the elevation of spatial unit 1.

22. UNDERCUT BANK AREA—This graph will have one line for each stream reach in the watershed. The value graphed is the total area of undercut banks along the stream reach in square meters.

23. PRES NET WORTH(TIMBER)—This graph has three lines showing the present net worth of timber harvest and road building in the watershed at three different discount rates (user input). This graph is not available for viewing as the simulation proceeds. It can be called up only after the entire simulation period is complete.

24. (available)—This graph currently is not being used.

25. HARVEST BY SITE CLASS—This graph will have five lines showing the cumulative acres of each site class that have been harvested.

26. PINK COMM: PERSONAL USE—This graph has two lines showing the commercial harvest and personal-use harvest of pink salmon. The personal-use values are typically very small compared to the commercial harvest and may appear as zero.

27. CHUM COMM: PERSONAL USE—This graph has two lines showing the commercial harvest and personal-use harvest of chum salmon. The personal-use values are typically very small compared to the commercial harvest and may appear as zero.

28. COHO COMM:PERS:SPORT—This graph has three lines showing the commercial harvest, sport harvest, and personal-use harvest of coho salmon. The personal-use values are typically very small compared to the commercial harvest and may appear as zero.

29. STREAM VELOCITY(M/SEC)—This graph will have a line for every stream reach in the watershed. The value graphed is the stream velocity in meters per second that is used to compute probability of bedload shift.

30. HUNTING EFFORT—This graph will have one line showing the hunting effort in hunter days that is being expended in the watershed.

31. KILL PER EFFORT—This graph will have one line showing the kill per unit of effort (one unit of effort equals one hunter day) in the current year in the watershed. This value is used to determine the nonlocal hunting effort in the next year.

32. COHO/SQ-M BY YEAR CLASS—This graph has two lines showing the number of coho per square meter in the entire stream system by coho age class.

33. SMOLT BY YEAR CLASS—This graph has two lines showing the number of coho smolt per square meter in the entire stream system by age class.

34. BEDLOAD SHIFT PROBABLE—This graph will have one line for each stream reach in the watershed. The value graphed is the probability of a bedload shift occurring in the stream reach during the year.

35. SUMMER LOW FLOW FACTOR—This graph will have one line for each stream reach in the watershed. The value graphed is the reduced survival of coho in a reach due to reduced summer stream flow. A value of 0.95 would indicate that 5 percent of the coho die as a result of reduced summer stream flow.

36. WINTER LOW FLOW FACTOR—This graph will have one line for each stream reach in the watershed. The value graphed is the reduced survival of coho in a reach due to reduced winter stream flow. A value of 0.95 would indicate that 5 percent of the coho die as a result of reduced winter stream flow.

37. (available)—This graph currently is not being used.

38. (available)—This graph currently is not being used.

39. SAVE OUTPUT, THEN QUIT—This option calls another menu that allows the user to save output on disk files before quitting the program.

40. QUIT WITHOUT SAVING—This option ends the SAMM run and returns the computer to DOS.

Appendix 3

Sample Data File for Geographic Description Input

VCUDATA.TST—Note that information in single quotation marks is included in the data file and is read as data by the program; it must not be deleted;

vcu information'

(one line per spatial unit in the vcu)'

label		slope	inear	ptrdrn	dfid	ptrsip	allude	ace'
sp unit	1'	0	1	1	1.0	1.	10.	1
	2'	0	1	2	4.5	1.	25.	1
	3'	0	1	4	4.5	1.	150.	1
	4'	0	0	2	6.2	0.6	650.	0
	5'	0	1	3	6.5	1.	575.	0
	6'	0	1	5	5.8	1.	600.	0
end data'		-99	-99	-99	-99	-99	-99	-99

spatial unit information'

' (one line per spatial-unit/site-class combination)'

' sp-ptr	site	acres '
1	110	1500
1	130	990
2	90	210
2	100	300
2	110	420
2	130	1800
3	100	840
3	110	522
3	130	474
4	70	132
4	90	360
4	100	432

```
  5      100     390
  5      110     468
  5      130     480
  6       90     312
  6      100     498
-99      -99     -99

'initial random seed (range=l-32000) use 0 to let program choose'
741     0
```

Appendix 4

Sample Data File for Hydrologic Input

HYDRODAT.TST—Note that information in single quotation marks is included in the data file and is read as data by the program; it must not be deleted.

```
           Cleveland 717
     xxx.
     'stream reach length (reachlen)'
2500  2000  1118  2093  500
     'cross secional area(crossarea)'
50.  23.  4.  17.  5.
     'ave width (reachwid)'
20.3 15.4  6.0  9.3 4.0
     'side channel surface area (areasidach)'
3000  2000   0  1000   0
     'area of stream bed in rubble (rubblearea)'
10000  5000   6775  548  0
     'pointer to order reaches will be considered (iorder)'
5  4  3  2  1
     'downstream reach from current one (idown)'
4  1 2  1  6  :
     'gravel area for,spawning by species (gravelarea) ROW=SP,COL=RCH'
24053  5951   556  4050   500
24053  5951   556  4050   500
12500  6000   556  4050   500
     'available water capacity per spatial unit ,inches (soilh2ocap)'
5 5 5 5 5 5 5 5 5 5
     'natural mean depth of undercut banks (ucutdepth)'
0.5  0.5  0.5  0.5  0.5  0.5
     'debris input at time of logging (debrisinput(1)'
0.1
     'equilib value for large debris m3/m2 (equilldeb)'
```

```
0.01   0.01    0.007   0.01    0.007
     ' equilib prop fox fine sediments (equilfsed)'
0.15    0.15    .15   .15     .15
     'prop of fine sed move out each year (propmove)'
0.5   0.5   0.9   0.5   .9
     'max % bedload shift (bedshiftmax)'
0.4   0.4   0.9   0.4    0.7
     'adjust stream velocity for edge effect (veladjust)'
0.4   0.3   0.5   0.3   0.5
     ' switch for stream cleaning, l=stream cleaning (istrmcin)'
0
     'flag for torrents 1-1st order stream (itorrent)'
0   0   0   0   0
     'solar angle by month (solarangle)'
13.2 21.83 32.15 44.09 53.18 57.88 56.05 48.79 37.79 26.06 16.06 11.15
     'standard deviation of temperature (stemp)'
32.85 31.8 33.6 36.5 41.8 49.2 55.2 58.6 58.7 53.1 45.8 38.4 33.9 32.85
     'standard deviation of precipitation (sprec)'
8.845 8.36 6.3 6.44 6.08 4.8 4.1 4.3 5.39 8.02 12.61 10.67 9.33 8.845
     'proportion of bank with streamside vegitation (propshaded)'
0.95 0.95 0.95 0.95    .95
      'coho first two age classes, col=rch, row=age (fwaterres)'
29537.    18445.     2523.    10904.     1073.
 6645.     4150.      568.     2453.      241.
      'total fry by species (totalfry)'

 9778840.       7909354.         88618.
      'ocean residents at the beginning of the simulation'
      'first row is pinks (1 age ciss) (oceanresidents)'
10136212.
      'second row is chum ( 4 age classes)'
 7909946.     1582053.      253129.       15187.
      'third row is coho (1 age ciss)'
    7359
         'water to snow conversion factor (wscon)'
8
         'temperature lapse rate (degrees/ft elev) (rtlaps)'
.0036
         ' snow melt rate (fmelt)'
.06    '.12 '
         ' std dev of temperature, summer winter (stdsum, stdwin)'
```

```
4.0   6.0
        'spread of daily temps,  summer,  winter  (sprsum, sprwin)'
7.0   6.0
        'proportion of 24 hours that is day (daying)'
.50
        'commercial harvest rate by species (commharvprop)'
.5  .5  .40
        'ocean survival rate by species (oceansurvrate)'
.02  .20  .10
        'prop of fish that go to subsistence users (subsharvprop)'
0.01
        'prop of fish that go to sport (ocean) sp (sportharvprop)'
0.0     0.0     0.10
        ' fish vulnerability to catch (fwvul)'
.000  .000  .001

        'long term summer stream flow (sumlongterm)'
46.5     22.9     6.1     12.2     3.7

        'long term winter stream flow (winlongterm)'
10.6      5.2      1.4     2.8     0.8

        'switch for ocean or terminal fishery (iharv)'
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0 1 1 1 1 1 1 1 1 1 1 1 1
        'switch for printout options in hydro, (ihd)'
1
        'switch to turn on the (1=) constant snow model (isncon)'
0
```

Appendix 5

Sample Data File for Deer input

DEERDATA.TST—Note that information in single quotation marks is included in the data file and is read as data by the program; it must not be deleted.

```
        'number of deer herds (numherds)'
1
        'initial deer per square mile (deerdensityinit)'
50.0
        'map deer herds to spatial units, one entry per spatial unit
(mapherds)'
1 1 1 1 1 1
        'local population (residenthunters)'
25
        'days/year each resident hunts (dayseachresidents)'
2
        'prop of loggers that hunt (prophunters)'
.5
        'days/year each logger hunts (dayseachloggers)'
2
        'max hunter days/year from outside local area (maxdaysdistant)'
10
        'gross energy equiv (grossenergy) forage class,season'
4500 4500 4500
4500 4500 4500
        'digestability factor (digestability) for class, season'
.70  .60  .70
.60  .40  .70
        'metabolizable energy factor (metabolizablefac)'
.80
        'body weight (weight) deer grp'
15.    27.
50.    43.
        'Kcal/kg of body weight (kcalkgbodywt)'
8400
        'net energy coefficient (netenergycoeff)'
 0.70
        'active metabolic rate factor [amfsummer(f,a),axnfwinter(f,a)]
season'
2.00  2.00
1.70  1.70
        'handling time modifier (dhmult)'
1.14      1.12
```

'handling times (dh) for els, deex grp, season'
'columns are forbs, shrubs, lichens, first line is fawns,summer'
'second line fawns,winter, then adults,summer, and adults,winter'

```
.40   .60   .40
.45   .80   .50
.30   .50   .30
.40   .60   .40
```

'preference factor (xpref) for cls, season .6 .2 .2'

```
.95 .16 .1
.95 .16 .1
```

'search rate (da) deer group'

```
1.00  1.00
```

'maximum survival rate, fawns, adults(survratemax)'

```
.75 .90
```

'fawning rate, adults (fawningrate)'

```
0.75
```

'metabolic costs for snow – fawns, by depth class (snowcost)'

```
0  200  600
```

'metabolic costs for snow. – adults, by depth class (snowcost)'

```
0  300  900
```

'max forb carrying capacities (forbmincapacity, forbmaxcapacity)'

```
100. 300.
```

'max shrub carrying capacities (shrubmincapacity, shrubmaxcapacity)'

```
15000.  50000.
```

'cutoff percent for net energy gain (cutoffpercent)'

```
0.00
```

'output level (for getting various intermediate print files)'

```
10
```

Appendix 6

Sample Data File for Management Plan Input

PLANDET.TST—Note that information in single quotation marks is included in the data file and is read as data by the program; it must not be deleted.

```
1 'year   spunit  acres   harvtype   %bankcut   5x  acreage   cut  each  site'
    20      1      20       1          40     0.0     0.0     0.0   50.0   75.0
    21      1      20       1           0     0.0     0.0     0.0   50.0  100.0
    22      1      20       1          40     0.0     0.0     0.0    0.0  200.0
    23      1      20       1           0     0.0     0.0     0.0   50.0   50.0
    24      1      20       1          10     0.0     0.0     0.0    0.0   50.0
    22      2      20       1          10     0.0     0.0     0.0   50.0   75.0
    23      2      20       1           0     0.0     0.0     0.0    0.0   65.0
    24      2      20       1          20     0.0     0.0     0.0    0.0  100.0
    25      2      20       1           0     0.0     0.0     0.0   50.0   80.0
    26      2      20       1          20     0.0     0.0    50.0   40.0  100.0
    27      2      20       1           0     0.0     0.0     0.0   40.0   35.0
    28      2      20       1          10     0.0     0.0     0.0   50.0   50.0
    24      3      20       1          10     0.0     0.0     0.0    0.0  100.0
    25      3      20       1          10     0.0     0.0    50.0   50.0   50.0
    26      3      20       1          10     0.0     0.0     0.0    0.0  100.0
    27      3      20       1           0     0.0     0.0    50.0   35.0    0.0
    28      3      20       1           0     0.0     0.0    50.0   35.0    0.0
    27      5      20       1          10     0.0     0.0     0.0   40.0   50.0
    28      5      20       1          10     0.0     0.0     0.0   75.0  100.0
    29      5      20       1          10     0.0     0.0     0.0   50.0   25.0
    30      5      20       1          10     0.0     0.0     0.0   50.0   50.0
    29      6      20       1          10     0.0     0.0   100.0    0.0    0.0
    30      6      20       1          10     0.0     0.0   100.0    0.0    0.0
   -99    -99     -99     -99         -99   -99     -99     -99    -99    -99
19    1  1.00   2.00
20    1  1.00   0.00
21    1  1.00   0.00
23    1  0.00   1.00
24    1. 0.00   1.00
20    2  1.00   1.00
21    2  1.00   0.00
25    2  1.00   1.00
27    2  0.00   2.00
22    3  1.00   1.00
26    3  0.00   1.00
26    5  1.00   1.00
29    5  0.00   1.00
28    6  1.00   1.00
```

```
-99    -99    -99   -99
 65   150    1    5  2   'year   residba   spunit   agecis   harvtyp'
 65   150    2   4   2
 65   150    2    5  2
 65   150    3   4   2
 65   150    3   5   2
```

Appendix 7

Sample Data File for Economics Input

ECON.DAT—This file contains all data necessary for economic analysis of a simulation. Note that information in single quotation marks is included in the data file and is read as data by the program; it must not be deleted.

```
    discount rates'
.05  .075  .1
    '2nd grwth mgmt costs, site prep, planting, thinning'
40  480  350
    'hauling costs/mile of road, CCMU'
60
    'wood hauling cost, CHAUL'
1.50
    'road maintenance costs, CMR'
.45
    'xnailnline road building costs, CBMR/
175000
    'spurline roadbuilding costs, CBRS'
120000
    'value of cedar, VALC'
1000
    'val of wood by vol class,0-8,8-20,20-30,30-50,50+mbf, VAL'
205.50   251.50   285.50   309.00   322.50
    'value of commercially thinned material'
100
    'harvest cost $/mbf by site, harvest method, CHT'
144  177  137  156  161  186  186  252  135  300  107
126  149  119  134  140  160  162  216  133  275  101
109  127  104  115  121  137  141  185  131  250   95
 90  103   85   94  101  114  119  156   99  243   79
 83   94   82   89   94  106  112  146   90  240   76
    'ac harvested/mi road by harvest method, RPH'
160  160  160  160  240  240  320  320   80  600   80
    'employment rate/mbf cut,/mi road,/mbf thin,/ac 2nd grth.ERATE'
.002  1  .002  .0056
    'prop of employment in hunting season(see ERATE).PDH?^
.7  .7  .7  1
```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Weyermann, Dale L.; Fight, Roger D.; Garrett, Lawrence D. 1991. A users guide for SAMM: a prototype southeast Alaska multiresource model. Gen. Tech. Rep. PNW-GTR-274. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 49 p.

This paper instructs resource analysts on using the southeast Alaska multiresource model (SAMM). SAMM is an interactive microcomputer program that allows users to explore relations among several resources in southeast Alaska (timber, anadromous fish, deer, and hydrology) and the effects of timber management activities (logging, thinning, and road building) on those relations and resources. This guide assists users in installing SAMM on a microcomputer, developing input data files, making simulation runs, and storing output data for external analysis and graphic display.

Keywords: Multiresource, forest management, software, microcomputer, users guide, models, timber, hydrology, fisheries, deer.

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