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F*ish*
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I*nteraction*
P*rogram*
M*anagement*
M*odel*

Draft User's Guide

DRAFT

FFIP - MM

Fish Forestry Interaction Program Management Model

Draft Users Guide

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Acknowledgements

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Table of Contents

Part

1

Introducing FFIP-MM

This section provides an overview of how the FFIP-MM prototype can be used to evaluate the impacts of alternative harvesting strategies on the value of fish habitat. You will be introduced to the major concepts underlying FFIP-MM and you will become familiar with the major steps required to use FFIP-MM for analysis purposes.

This section also describes the system requirements, installation instructions, and other important information you need to get started.

Part 1 Contents

CHAPTER 1

Introducing the FFIP-MM Prototype

Introduction

The Fish Forestry Interaction Program Management Model (FFIP-MM) is a prototype coastal watershed management tool. Its purpose is to link upslope forest harvesting activities to changes in stream sediment and large organic debris (LOD) transport processes. The rate of delivery of LOD sediment from hillslopes is then related to reach specific impacts for several fish species. Ultimately, a watershed habitat capability (WHC) rating is calculated to reveal the cumulative effects of changing LOD and sediment budgets on fish.

To the best of our knowledge, FFIP-MM is the first tool that links upslope forest harvesting impacts on sediment and LOD transport processes to site specific impacts on fish habitat. The prototype can answer questions like: how likely are debris slides to be transmitted from one part of the watershed to another; how long will it take for the watershed to recover from a particular intensity of harvesting; and, what are the reach specific and cumulative watershed impacts of harvesting on fish?

The three sections of this user's guide cover the necessary information for using FFIP-MM in its current stage of development. Part 1 provides a brief overview of model purpose, structure, and data requirements. It also tells you how to install FFIP-MM. Part 2 describes the required input data and how to prepare it for use in FFIP-MM. It also describes how to set up a management scenario and run a simulation. Part 3 describes how to store and view simulation output. For details of model calculations and assumptions see the accompanying FFIP-MM report[1].

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1 **Alexander, C.A.D.** 1998. The Fish Forestry Interaction Project - Management Model (FFIP-MM): Preliminary Results of an Application to Carnation Creek, British Columbia. Prepared by ESSA Technologies Ltd., Vancouver, BC.

Using this Manual

This User's Guide is a draft document, and as such, some sections of it are in process. The User's Guide is divided into parts that discuss the major steps involved in setting up the model, carrying out runs, and analyzing results. Please consult the Table of Contents to find specific information.

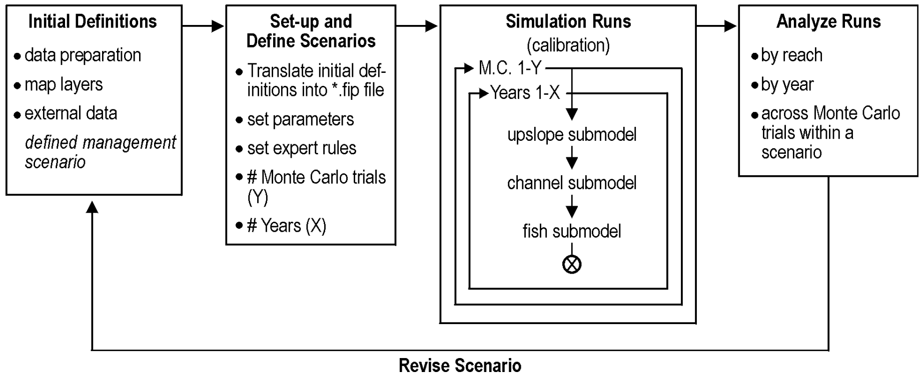
Capabilities and Limitations

Advantages: links upslope harvesting impacts on LOD and sediment transport processes to site specific impacts on fish habitat capability; evaluation of logging plans for the probability and range of possible outcomes on fish habitat capability, teaching tool for fish-forestry linkages, improves communication and scientific understanding by bringing teams from diverse disciplines together to synthesize professional judgment, uses standard geographic information, uses a realistic level of complexity given data availability and current scientific understanding of the key processes.

Limitations: only applicable to small ($< 40km^2$), steep, coastal watersheds, expert opinions open to debate, prototype supports a limited range of management actions and regulations, not all independent variables for slide volume regression equations available to the model, mass wasting dynamics on old growth terrain, stands simply viewed as an average volume over the debris slide path, many other factors other than stream morphology and disturbance state affect fish density.

Stages of the Analysis Process

There are four stages that you need to work through when using FFIP-MM, as shown in the diagram below:



Initial Definitions

FFIP-MM requires two types of externally prepared data: 1) spatial information in the form of several map grid files; and 2) map attribute information in an external database. The six map layers required are: 1) elevation (m), 2) forest cover polygons, 3) slope stability[2], 4) road location and age, 5) gullies, 6) and streams. You must use a GIS application to convert GIS map information to a grid file (e.g., a shape file in ArcView to an ASCII exportable grid theme) for each layer. An external database contains the required data for the forest cover and stream map layers.

Set-up and Define Scenarios

The above spatial and external information defines model scenarios in combination with user defined model parameters and expert rules. The parameters and rules are used in functions that describe relationships within FFIP-MM's three submodels. For example, the growth and yield of stands, the probability of slope failure, characteristics of debris travel distance, and variation in stream flushing rates.

In the FFIP-MM prototype, a scenario is the overall combination of external and internal data and model settings. A new scenario can be as simple as a change in the management actions that are currently performed using GIS.

Depending on where you make changes, spatial pre-processing may be required. This step is discussed in Part 2.

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2 **BC Ministry of Environment.** 1995. Forest Practices Code of British Columbia: Mapping and Assessing Terrain Stability Guidebook. Canadian Cataloguing in Publication Data. 34 pp.

Simulation Runs

For a scenario, FFIP-MM simulates the requested number of years in annual time steps. The model runs the scenario as many times as requested by the user. At least 50 Monte Carlo trials should be performed to generate stable results. Each Monte Carlo run has a different random number seed, representing alternate outcomes of the stochastic processes modelled by FFIP-MM. This permits the model's output variables to be displayed as distributions to indicate the relative risks of different outcomes for a given scenario.

Analyze Runs

During a model run, the results are saved to a separate output database that is then queried to provide graphs of results at the end of the model run. You can review results spatially and graphically.

FFIP-MM Analysis Components

FFIP-MM consists of several components that work together during the analysis process described above. Each component is introduced briefly below and is either described in detail later in the User's Guide or in other FFIP-MM documentation.[3]

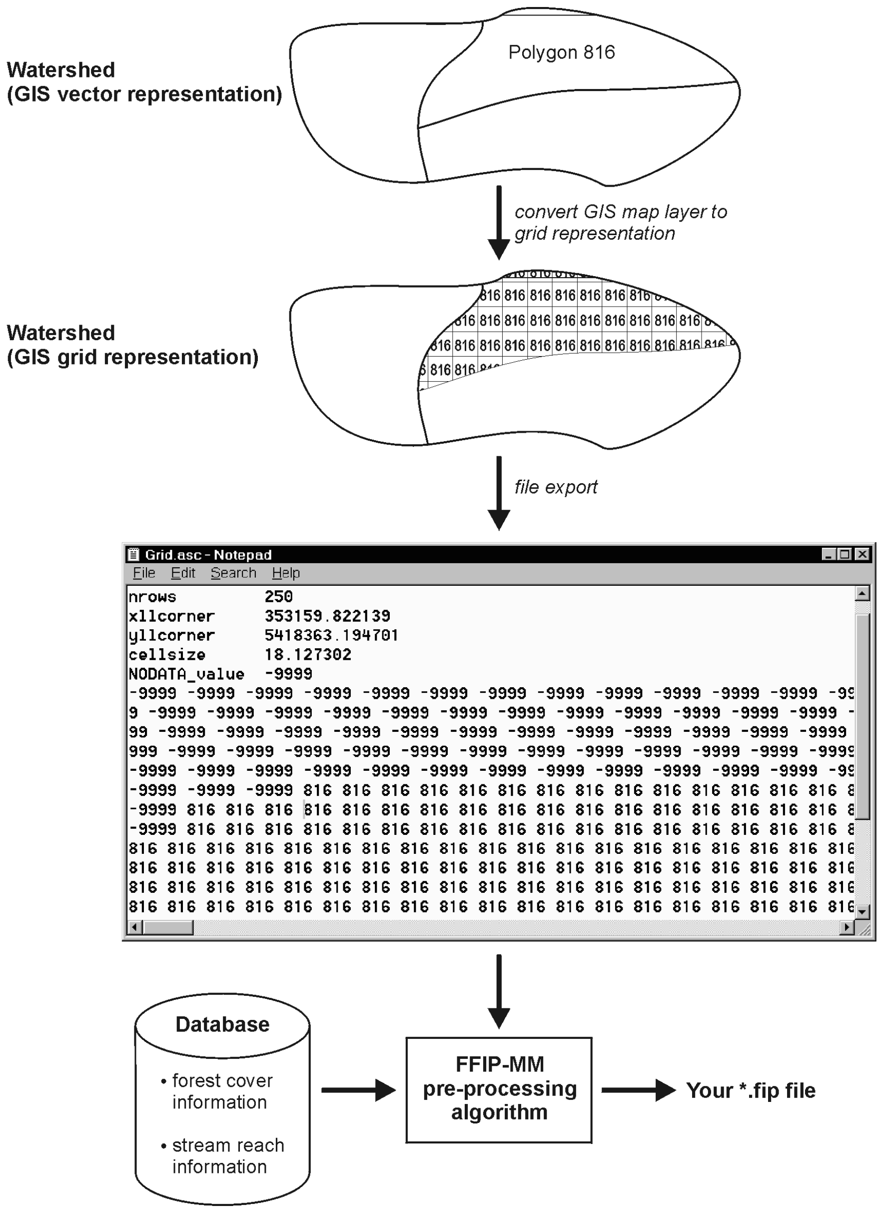
[3] **Alexander, C.A.D.** 1998. The Fish Forestry Interaction Project - Management Model (FFIP-MM): Preliminary Results of an Application to Carnation Creek, British Columbia. Prepared by ESSA Technologies Ltd., Vancouver, BC.

Component	Description
Map-preprocessing	Transfers the required spatial and external information describing the watershed into the *.FIP file.
FFIP-MM Database	Stores output from the simulations. Used for post simulation analysis. Can be saved and renamed.
Submodels	Upslope, Channel, and Fish submodels translate changes in watershed upslope characteristics and channel disturbance states into changes in Watershed Habitat Capability (WHC) ratings for several fish species and life stages.
Dynamic Map Display	Dynamic plotting of debris slide paths and relative size over the course of a simulation. Dynamic plotting of forest age structure and stream reach CAP state.[4]
Analysis graphs	Displays WHC information for each fish species, along with diagnostic output for all major submodel variables.

[4] **BC Ministry of Environment.** 1996. Forest Practices Code of British Columbia: Channel Assessment Procedure Field Guidebook. Canadian Cataloguing in Publication Data. 97 pp.

Map-Based Information

FFIP-MM requires map-based information that defines the watershed in terms of elevation, forest cover, road layout, gully position, stream reach network, and slope stability.


Watershed
(GIS vector representation)
Polygon 816
convert GIS map layer to
grid representation
Watershed
(GIS grid representation)
file export
Grid.asc - Notepad
File Edit Search Help
nrows 250
xllcorner 353159.822139
yllcorner 5418363.194701
cellsize 18.127302
NODATA_value -9999
Database
• forest cover information
• stream reach information
FFIP-MM
pre-processing
algorithm
Your *.fip file

CHAPTER 2

Getting Started

This chapter describes the information you need to install and run FFIP-MM.

System Requirements

FFIP-MM is designed to run on high-end personal computers with the following minimum hardware requirements:

a Pentium-class processor, 200 MHZ or better strongly recommended;
at least 64 megabytes of RAM (128 megabytes is ideal);
a hard disk with 300 megabytes or more of available space; and
a 17" (or larger monitor is highly recommended.

The amount of free disk space needed will vary according to the type of analysis and the number of simulation runs that are conducted. More powerful systems will result in increased performance of the software and, as with all spatially explicit models, a large amount of free disk space is highly recommended. External data storage options such as a one-gigabyte Jaz™ drive will give you greater flexibility.

The model runs under a 32-bit operating system such as Windows NT (4.0) or Windows 95. Access to, and familiarity with, the following software will improve analysis flexibility.

Microsoft Access 97; and
GIS software capable of producing ASCII grid files.

It is expected that you have a basic familiarity with some GIS application. (ArcView was used to supply the grid files for prototype development. Using ArcView will ensure that FFIP-MM receives the map-based information in the correct format.)

Installation Instructions

Installing FFIP-MM

To install FFIP-MM on your computer:

1. Place CD in CD-Rom Drive;
2. In Windows NT or 95/98 *Control Panel* choose **Add/Remove Programs**.
3. Click *Install,* and follow the on-screen instructions.
4. Read the *"Readme.txt"* file once setup is complete.

Describe where the program files are saved to.

Technical Information

The FFIP-MM Database

You have been provided with a database file called **FFIPMM.mdb** which contains all of the data tables used to store model outputs. Do not attempt to alter the field names or data types in this table using MS Access. *Any time you run a model scenario, the contents of the specified target database are permanently deleted*, and the new results are added. This design feature minimizes consumption of hard disk space but forces you to manually manage your output database files. It is a very good idea, therefore, to copy and rename (with descriptive file names) the databases you want to keep for future analyses.

In future analyses, databases with the names you provided them (edited with Windows Explorer™) can be accessed by FFIP-MM, and their contents queried from FFIP-MM to display the results for the particular scenario. The standard query functionality of MS Access can also be used to generate specific results not produced by FFIP-MM's queries.

Because FFIP-MM addresses problems that require a spatially explicit treatment, it produces a large amount of output. For example, for a 60-year simulation over 100 Monte Carlo trials, the FFIPMM.mdb database will grow to well over 100MB. To conserve disk space and improve query performance on the database, it is a good idea to periodically compact the database. This is achieved using MS Access's Compact Database feature.

Backing Up Your Work

Two other files are extremely important to the proper functioning of FFIP-MM. These are your ***.FIP** file and the external MS Access database defining forest cover polygons and stream reach characteristics. We suggest you back up these files on a regular basis.

It is a good practice to copy and rename or assign *.FIP files names that will permit them to be readily associated with a particular output database. This way, you can review the parameters and expert rules that produced a particular set of results.

You should also retain the original installation CD in case you need to reinstall any model component.

Getting Help

You can answer many of your questions about FFIP-MM by consulting the table of contents of this User's Guide. Technical support questions can also be addressed to Clint Alexander at the Vancouver office of ESSA Technologies Ltd.:

Telephone: (604) 733 – 2996
Fax: (604) 733 – 4657
E-mail: calexander@essa.com

We are very interested in your comments and feedback.

Additional information about FFIP-MM can be found in the following documents:

1. **Alexander, C.A.D.** 1998. The Fish Forestry Interaction Project - Management Model (FFIP-MM): Preliminary Results of an Application to Carnation Creek, British Columbia. Prepared by ESSA Technologies Ltd., Vancouver, BC.
2. [*document*].

Part

2

Running Scenarios

This section describes the process of setting up scenarios and preparing the model to run. You will learn:

how to pre-process map and external data;
how to define scenarios using the internal settings; and
how to run a scenario.

Part 2 Contents

CHAPTER 3

What is a FFIP-MM Scenario?

At this time, a FFIP-MM scenario is a single combination of map information, external database information, and internal parameter and rule settings. To create a scenario, changes are made in one or more of these four areas. At this time, the prototype model does not include any algorithms for automating the generation of alternative management scenarios.

You can make changes outside and inside of the model. Outside areas are the GIS steps required to properly produce the necessary ASCII grid files which occur independently of the model, along with the preparation of the necessary external database information. Inside areas are the model parameters and expert rules that you set or confirm before running a scenario.

Depending on where you make changes, you must be aware of the different procedures that will be required to implement the scenario. For example, when changes are made to a map layer in a third party GIS application, the FFIP-MM pre-processing step must be followed. However, when changes are made in an external database (e.g., date of forest harvest), you can use your previously defined *.FIP file for the watershed, and when asked if changes were made to the forest cover or harvest inforestation, respond appropriately. These procedures are discussed in the next sections.

CHAPTER 4

Preparing a *FIP File

What is a *.FIP File?

Before you can run a FFIP-MM scenario you must prepare a *.FIP file. The *.FIP file translates the spatial grid file information into a format that simplifies model computations and stores the table and field names for the forest cover and stream reach information found in the external database. The *.FIP file also stores all of the values for model parameters and expert rules.

Note that the * is a wildcard symbol. It represents the name of your watershed. For example, *.FIP could be WATERSHED.FIP.

When Do You Need to Prepare a *.FIP File?

There are several circumstances that require the preparation of a *.FIP file:

- to prepare a new watershed data for analysis;
- to update a previously created *.FIP file if changes are made to the maps (e.g., changes to the location of natural features, roads, or cutblocks);
- to update a previously created *.FIP file if you change the structure of the external database (e.g., table or field names are changed); and
- to update a previously created *.FIP file if you change the location of the external input database on your system.

Once created, the *.FIP file is easy to load for future analyses.

TIP: To maintain model parameters and expert rules, but change the spatial information, load in a *renamed* <u>copy</u> of an earlier *.FIP file and regenerate the watershed information using the steps that follow.

Making a New *.FIP File

To prepare your *.FIP file, follow the steps below:

1. Start FFIP-MM.
2. From the main screen menu select "File|New".
3. The "New Watershed Properties" dialogue box will appear.
4. Enter the name of your watershed. This will become the name of the *.FIP file.

Using the "New Watershed Properties" dialogue box, you now tell FFIP-MM where to locate your spatial and external data.

Locating Spatial Grid Files

You must now locate the six ASCII grid files for FFIP-MM created using a third party GIS application. To do this:

1. Select the "Spatial Data Files" tab of the "New Watersheds Properties" screen.
2. Under "Select a map layer" there is a drop down list of the required map layers.
3. Select a map layer to import (e.g., "Forest cover polygon map.asc").
4. In the corresponding text box (e.g., "Forest cover polygons:"), either type in the file path and file name of the map layer file, or
5. Click "Browse" to search through your directories for the required file.
6. When you have located the file, click on the file name.
7. The name of the map file should now appear in the appropriate text box.
8. Repeat steps 2-7 until all six map layers have been located and their names appear in their *respective* text boxes.

Locating Forest Cover and Stream Reach Information

You must now locate the external database and identify the fields that contain the forest cover and stream reach data. To do this:

1. Select the "External Databases" tab. Two sub-tabs will appear, "Forest Cover Information" and "Stream Reach Information".
2. Select the "Forest Cover Information" tab.
3. Select "Browse" to locate the path for the external forest cover database on your system.
4. In the left panel, expand the database tree to show the database's tables.
5. Left click on the appropriate node ⊞ to show the fields each table contains.
6. The darkened pane on the right lists the field names that FFIP-MM will associate with the database fields. Table 1 provides descriptions of these required fields.
7. You must associate the appropriate external database fields with their FFIP-MM names in **sequential order** from the top to the bottom of the list.
8. To associate the external database fields with the FFIP-MM names first click on the field in the tree view pane, then
9. Select the field to be associated with the FFIP-MM field name in the left pane with a right mouse click and choose "Add". It is not necessary for the names to be the same. It is only necessary that the external field contains the correct data.
10. The name of the selected field will appear in the middle darkened pane beside its associated FFIP-MM name.
11. Repeat this procedure for all the "Forest Cover Information" fields.
12. Once finished, select the "Stream Reach Information" tab, and repeat the same process as for "Forest Cover Information". Table 2 provides a description of the required stream reach fields.

Table 1: Forest cover information.

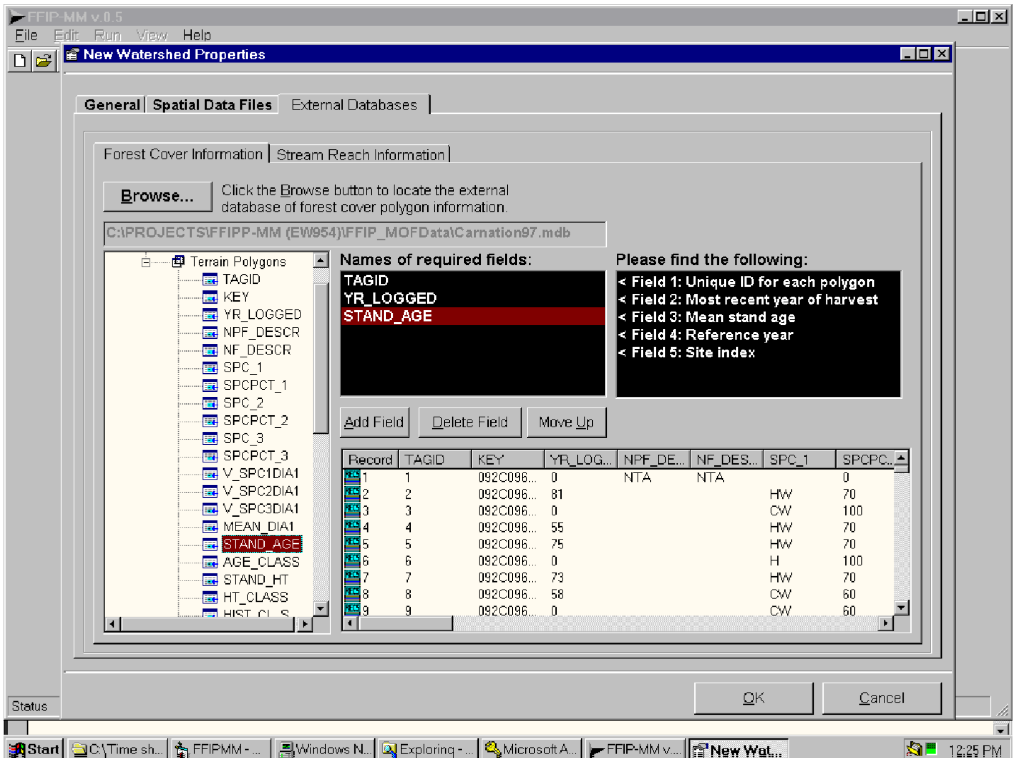
Field	Description
Unique ID for each polygon	Integer matching the values in the forest cover grid file.
Most recent year of harvest	Age you wish to harvest a given polygon.
Mean stand age	Stand age in the reference year.
Reference year	Year age structure inventory performed
Site index	An expression of the forest site quality based on stand age and height. Site index is determined using stand age, stand height and Ministry of Forests' and other site index equations. These equations are based on reference age 50 years bha (Breast Height Age).

Table 2: Stream reach information.

Field	Description
Unique ID for each reach	Integer matching values in the stream reach grid file.
Average length (m)	Length of each given reach in metres.
Average width (m)	Width of each given reach in metres.
Average depth (m)	Depth of each given reach in metres.
Equilibrium CAP type	CAP type in dynamic equilibrium.
Initial CAP state	CAP state in the year you wish to start the simulation.
Pristine CAP state	CAP state in dynamic equilibrium.
Downstream reach ID	Determines what reach receives upstream LOD and sediment.

Viewing the Contents of the Input Database Tables

To view the contents of field, select a database table, right click, and choose “Explore Reach Properties Database Table”. The table’s fields and data are displayed in the bottom right pane of the dialogue box. This feature is useful to check whether a database field holds the information you require.



Starting the FFIP-MM Pre-processing Algorithm

Once you have named your watershed, located the spatial data (ASCII grid files), and located the external database fields, Click “OK” to start the FFIP-MM spatial pre-processing algorithm. The status of the operation will be indicated by a progress bar.

After the spatial information has been translated, a series of dialogue boxes will appear asking you to save bitmaps of this information. FFIP-MM then displays your watershed internally. These views are useful diagnostically to ensure the translation process successfully reproduced the correct spatial information.

Using a New *.FIP File for the First Time

Once FFIP-MM has completed translating the spatial grid files to the native format, it will automatically begin generating maps of this information for display within FFIP-MM. These maps are saved as bitmap (*.bmp) files for future use. The locations of these files are stored in the *.FIP file.

The spatial information content of the *.FIP file will be the only thing present when you first start FFIP-MM with a new *.FIP file. All of the model's parameters and expert rules will be set to their default values. Because re-setting these parameters is time consuming, it is suggested that you copy and rename the "Carnation Creek.FIP" file supplied during the installation, and then regenerate the spatial information for your watershed using the same steps outlined above.

An Important Note on Grid Files

ArcView was used to generate the ASCII grid files used in the development of FFIP-MM. We assume that other GIS applications such as ArcInfo possess functionality for producing ASCII grid files. Whatever GIS application you intend on using, the output ASCII grid file for the six required map layers must have the following headers at the top of the file (the numbers beside them will of course vary):

```
ncols           368
nrows           250
xllcorner       353159.822139
yllcorner       5418363.194701
cellsize        18.127302
NODATA_value    -9999
```

If your GIS application does not include these headers, or uses different ones, you must manually add/replace them with the headers above. The spatial pre-processing algorithm uses the values beside ncols (number of columns), nrows (number of rows), cellsize (grid cell length and width in metres), and NODATA_value (tells pre-processing algorithm that a particular grid location is outside the area of interest). While the model does not use xllcorner and yllcorner, please add them to ensure successful operation of the pre-processing algorithm.

It is critical that all six grid files have the same values for ncols, nrows cellsize, and NODATA_value to ensure each grid point represents the same point in the watershed.

You can view one of the *.asc files supplied during installation using a text editor like Notepad to see an example of a correctly formatted grid file.

Scenarios

About Scenarios

By creating scenarios, you can assess how logging strategies interact with the watershed's slope failure properties and stream types to alter fish habitat capability over defined periods of time from years to decades.

For example, you could create several scenarios that shared the same set of assumptions about slope failure probabilities, debris flow travel distance, and the expected pristine condition of streams, but had different logging road and cut-block locations. You could then examine the output of the scenarios to better understand how the effects of different logging plans effect the watershed's fish habitat capability. Alternatively, you could examine one logging plan and examine the sensitivity of the model results to different parameters and expert rules.

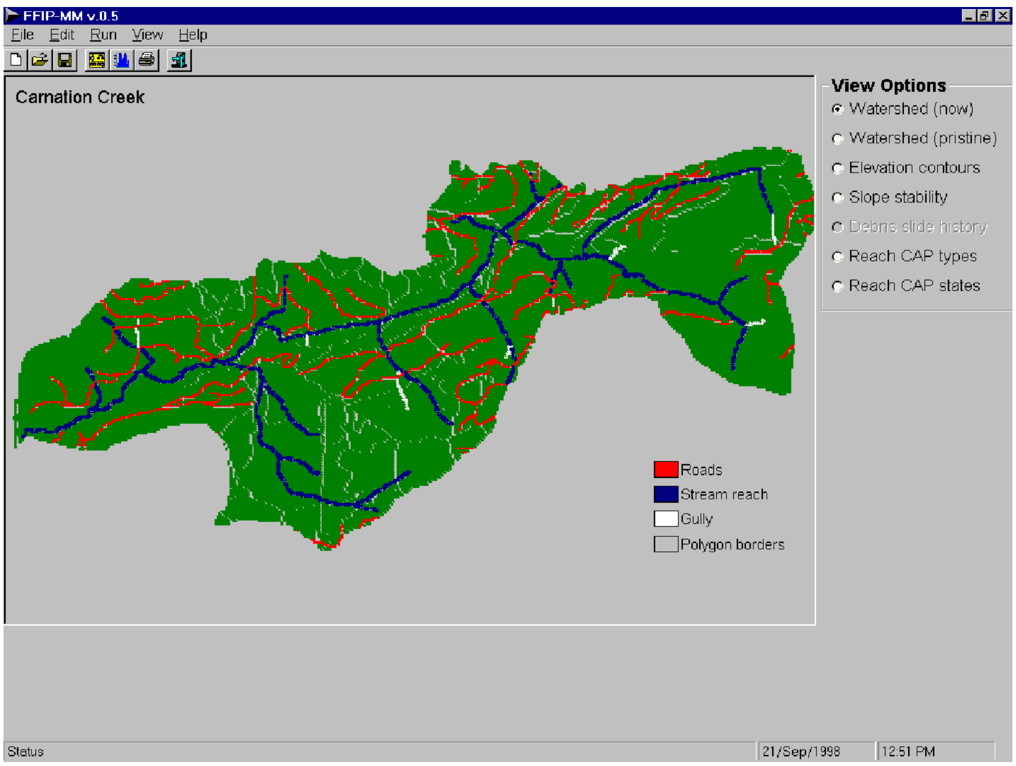
Before setting up and defining your scenarios, you (or others) will have to design the spatial lay-out of the harvesting plan using GIS software, and then convert this vector information into the required ASCII grid files described earlier. These files describe road locations, cut blocks, the number of stream reaches in the watershed, the position of gullies, and all other spatial information. You define the spatial elements of a scenario by designing and importing this information. Future versions of FFIP-MM will automate this process.

We assume the necessary GIS expertise will be available to you. Therefore, for purposes of familiarizing you with FFIP-MM, we look at the process of defining model parameters and expert rules for the model's three major submodels.

Model Parameters and Expert Rules

Once you have prepared the spatial components of the *.FIP file you must set or check the model parameter and expert rule settings. These options are found under "Edit" which will be enabled after the *.FIP file is opened or created. To check your settings, follow the steps below.

1. On the Main Menu, select File|Open.
2. Open the *.FIP file for your watershed. FFIP-MM will load your watershed file and display the watershed map on the Main Screen.



As a means of displaying FFIP-MM's interpretation of the spatial information you supplied, the "View Options" section will allow you to see the different features of the watershed.

3. Select "Edit". Under Edit you can change model parameters and expert rules. The dropdown menus list the options available.

Harvesting Guidelines

A management submodel for simulating management actions was not developed for the prototype model.

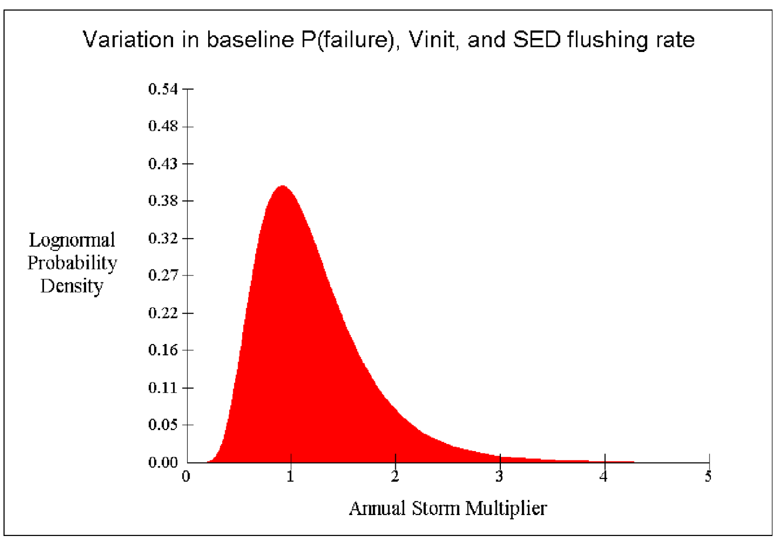
Storm Intensity Multipliers

From the Main Menu select "Edit|Storm Intensity Multipliers". On this screen you can set the parameters that define the log-normal probability distributions describing the natural variation for P(slope failure), Vinit (initial slide volume), FS (SED flushing), and FL(LOD flushing). Change the Mean multiplier and Multiplier standard deviation of each distribution in the text box provided. You can view each of these distributions by selecting "View". Table 3 lists these parameters and their definitions. Figures show the shapes of the distributions under example settings.

Select the "Edit" tab to view and define the relationship between the probability of slope failure and relative storm intensity.

Table 3: Table of parameters and expert rules.

Parameter/Expert Rule	**Definition**
P(slope failure)	Probability of scope failure ($ha.yr^{-1}$).
Vinit	Initial slide volume (m^3).
FS(SED flushing)	Proportion coarse sediment flushed out of a reach per year.
FL(LOD flushing)	Proportion of large organic debris flushed out of a reach per year.

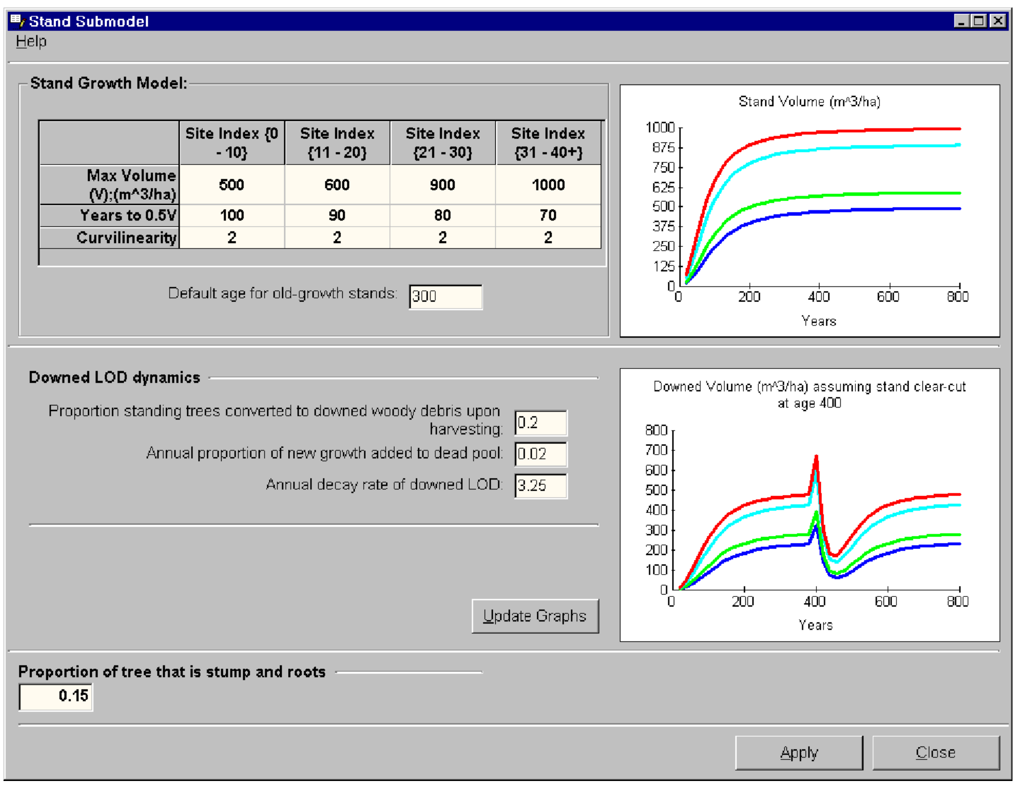


Upslope Submodel

From the Main Menu select "Edit|Upslope Submodel" and you will see several options. These options are discussed below.

Forest Growth

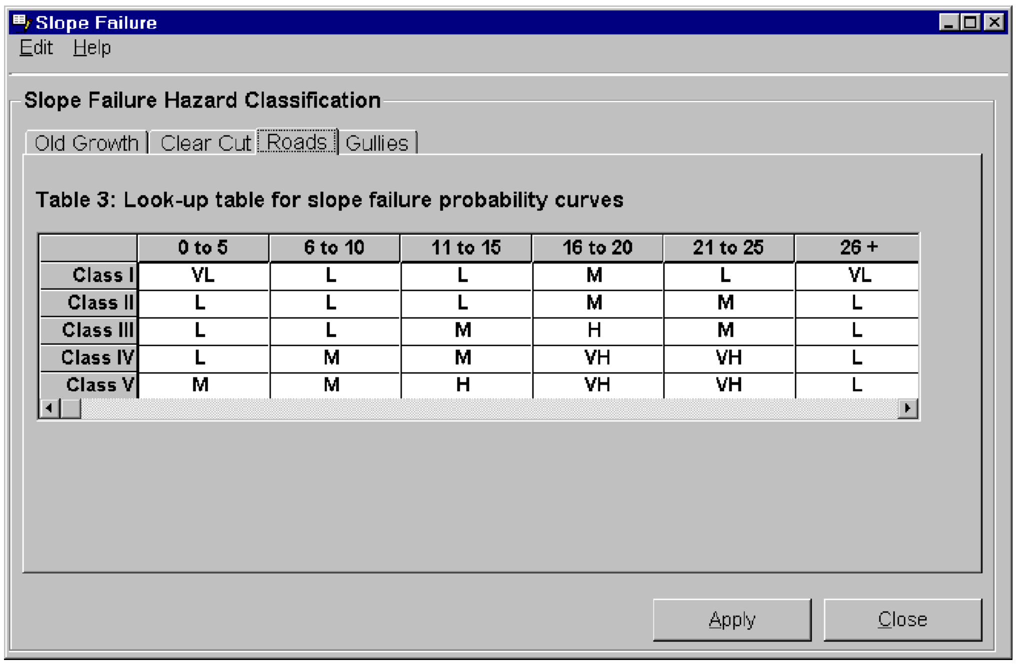
This screen displays and allows you to change parameters for the "Stand Growth Submodel". You are asked to supply parameters describing your forest's volume growth as a function of stand age and site index, as well as to provide decay parameters describing the volume of dead, downed LOD over time. A default age for old growth stands must also be supplied. Also, when calculating LOD entrainment on clear-cut terrain, the model requires that the proportion of a tree that is stump and roots (not removed from the site) be supplied. The graphs show a visual representation of stand growth and downed LOD dynamics over time. Click "Update Graphs" to view changes to these parameters.



Slope Failure

On this screen you can set the slope failure hazard classification for Old Growth, Clear Cut, Roads, and Gullies as a function of slope stability class (I through V).[5] The accepted values are:

```
"VL" = very low hazard
"L"  = low hazard
"M"  = medium hazard
"H"  = high hazard
"VH" = very high hazard
```



	0 to 5	6 to 10	11 to 15	16 to 20	21 to 25	26 +
Class I	VL	L	L	M	L	VL
Class II	L	L	L	M	M	L
Class III	L	L	M	H	M	L
Class IV	L	M	M	VH	VH	L
Class V	M	M	H	VH	VH	L

Ensure that you do not enter in a value such as "LH" as this will not be recognized at run time and may cause unexpected errors.

For Clear Cut and Old Growth terrain, values are further arranged by age. For example, for clear-cuts completed within six years, the value for the slope failure hazard classification would be entered in under the "0 to 5" column.

Failure Curves

Select "Edit|Failure Curves" to assign the parameters for slope failure probability per hectare per year to the five failure hazard classes. In FFIP-MM, the probability of slope

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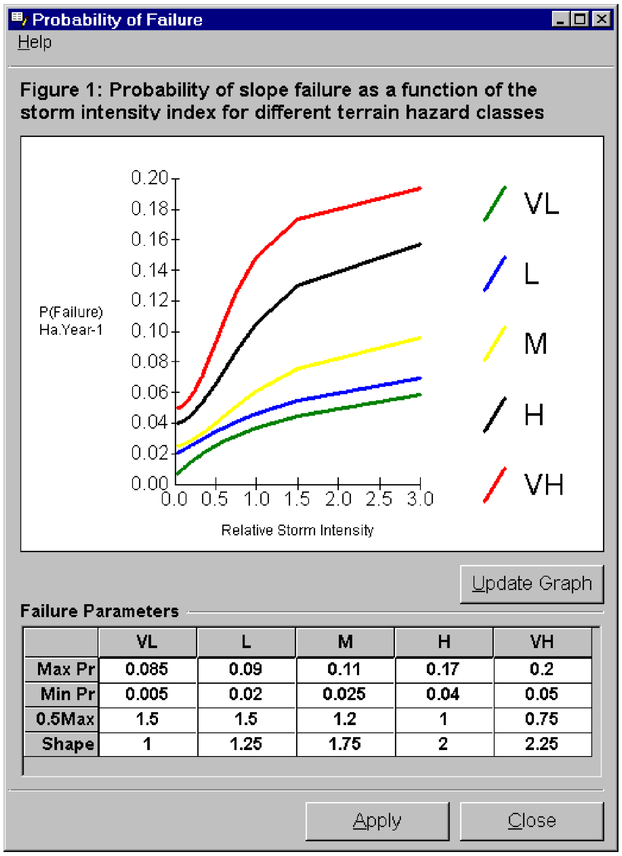
5 **BC Ministry of Environment.** 1996. Forest Practices Code of British Columbia: Channel Assessment Procedure Field Guidebook. Canadian Cataloguing in Publication Data. 97 pp.

failure depends on the log-normal random variable, “Relative Storm Intensity”, whose parameters are set as described under the heading Storm Intensity Multipliers above.

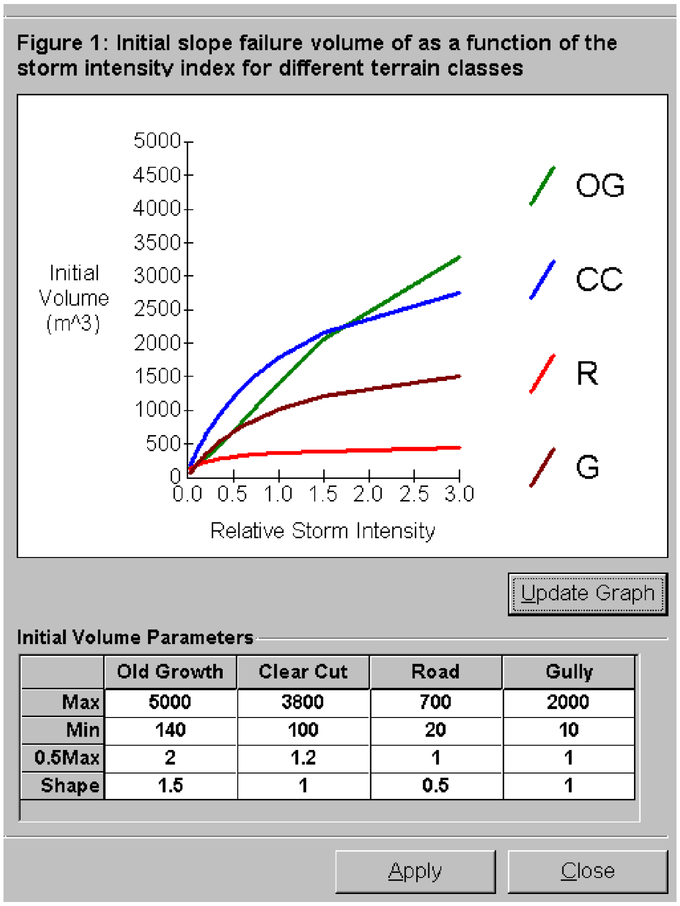
Important: Whenever changing the values of the Annual Storm Multipliers (= Storm Intensity Multipliers) for the probability of slope failure, you should recalibrate these failure probability curves.



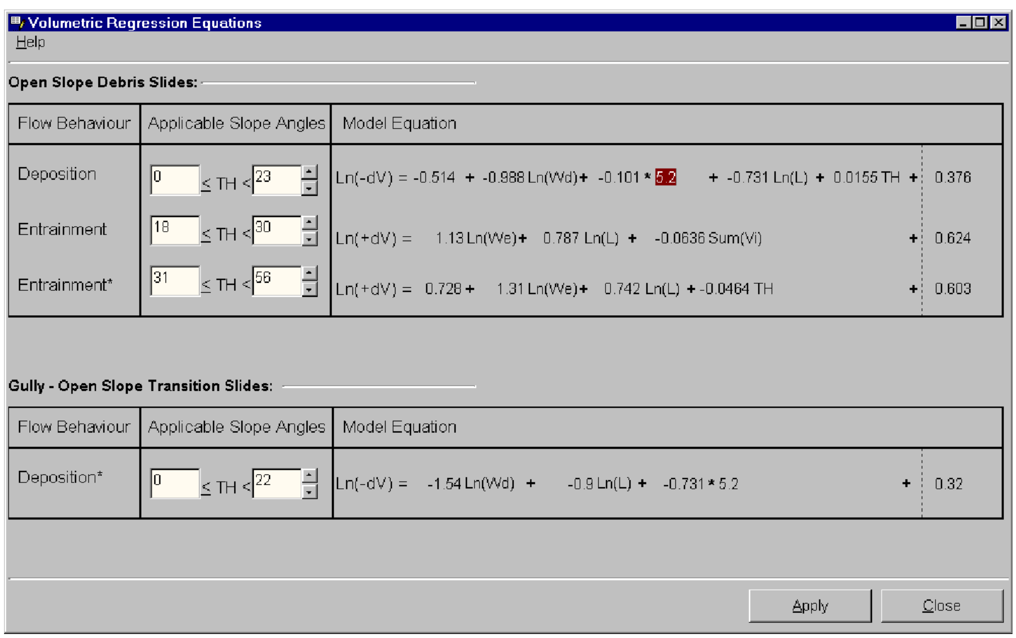
Debris Run-Out

Under the “Edit” tab there are two choices: “Initial Slide Volume” and “Volumetric Regression Equations” Under “Initial Slide Volume” you can set the relationship between initial slide volume and relative storm intensity. Under “Volumetric Regression Equations” you can set the volumetric regression equations. These volumetric regression equations, which determine debris slide travel distance and magnitude are describe in detail in Wise (1997).[6]

6 **Wise, M.P.** 1997. Probabilistic modelling of debris flow travel distance using empirical volumetric relationships. M.Sc. Thesis, Department of Civil Engineering. University of British Columbia, Vancouver, BC. 274 pp.



	Old Growth	Clear Cut	Road	Gully
Max	5000	3800	700	2000
Min	140	100	20	10
0.5Max	2	1.2	1	1
Shape	1.5	1	0.5	1



LOD Entrainment

This dialogue allows you to set the average proportion of LOD entrained by debris slides of different magnitudes. Standing LOD (live growing forest), Downed LOD (volume of the forest's dead pool), and stumps (on clear-cut sites) are assumed to be entrained at different rates by slides of different magnitudes (volumes). Here, you determine what volume of a debris slide entering a particular point would be characterized as a "Small event", "Medium event" and "Large event".

Gully Yield and Recharge

In this box you set the gully sediment yield assumptions.

Yield

Coarse sediment yield rate (m^3 coarse sediment / m gully)
Critical slope angle above which the yield rate is applied

Recharge

Number of years until a gully is fully recharged.

Channel Submodel

From the Main Menu select "Edit|Channel Submodel".

LOD and SED Storage

Table 1: CAP state specific LOD storage as a proportion of reach volume.

This table contains the values of LOD stored by the seven different CAP types[7] in the severely degraded (D3), stable (S), and severely aggraded (A3) states. These proportions are used during channel submodel calibration and initialization to determine sediment and LOD flushing rates and equilibrium LOD storage volumes in each reach. Linear interpolation is used to obtain the values for the CAP states not shown in the tables.

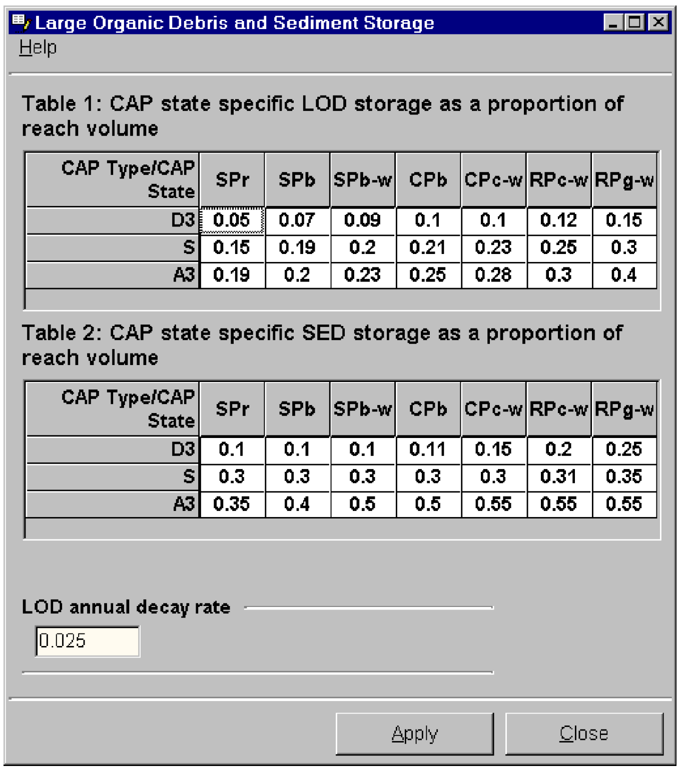
[7] **BC Ministry of Environment.** 1996. Forest Practices Code of British Columbia: Channel Assessment Procedure Field Guidebook. Canadian Cataloguing in Publication Data. 97 pp.

Table 2: CAP state specific SED storage as a proportion of reach volume.

This table contains the values of coarse sediment (SED) stored by the seven different CAP types[8] in the severely degraded (D3), stable (S), and severely aggraded (A3) states. These proportions are used during channel submodel calibration and initialization to determine sediment flushing rates and equilibrium SED storage volumes in each reach. This table is also used to calculate CAP state at run time. Linear interpolation is used to obtain the values for the CAP states not shown in the tables.

Logically inconsistent values entered in tables 1 and 2 will result in an error message.

An LOD decay rate is used to define the annual rate of LOD loss through decomposition and to indirectly account for loss in sediment capture effectiveness of older LOD jams.


Large Organic Debris and Sediment Storage

Help

Table 1: CAP state specific LOD storage as a proportion of reach volume

CAP Type/CAP State	SPr	SPb	SPb-w	CPb	CPc-w	RPc-w	RPg-w
D3	0.05	0.07	0.09	0.1	0.1	0.12	0.15
S	0.15	0.19	0.2	0.21	0.23	0.25	0.3
A3	0.19	0.2	0.23	0.25	0.28	0.3	0.4

Table 2: CAP state specific SED storage as a proportion of reach volume

CAP Type/CAP State	SPr	SPb	SPb-w	CPb	CPc-w	RPc-w	RPg-w
D3	0.1	0.1	0.1	0.11	0.15	0.2	0.25
S	0.3	0.3	0.3	0.3	0.3	0.31	0.35
A3	0.35	0.4	0.5	0.5	0.55	0.55	0.55

LOD annual decay rate

0.025

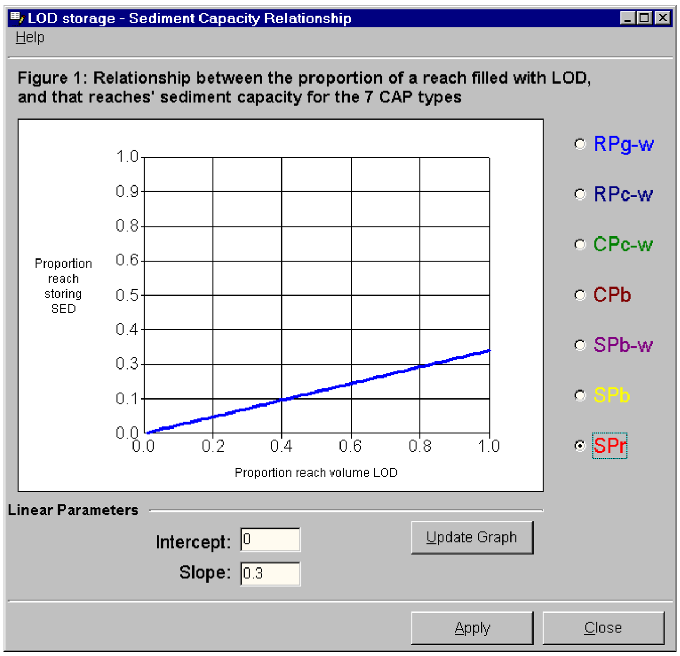
Apply Close

8 **BC Ministry of Environment.** 1996. Forest Practices Code of British Columbia: Channel Assessment Procedure Field Guidebook. Canadian Cataloguing in Publication Data. 97 pp.)

Sediment Capacity

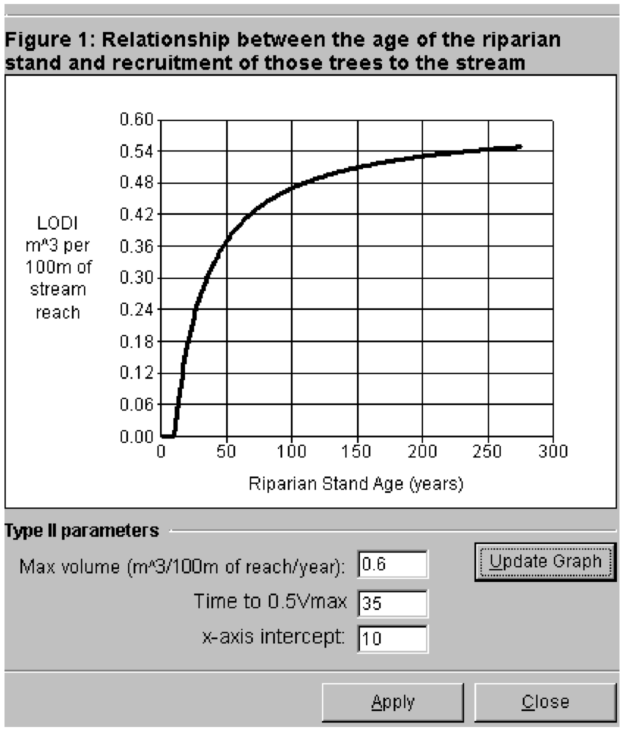
This dialogue box is used to specify sediment trapped by LOD for the seven different CAP types. This proportion of sediment is not subject to normal, annual stream flushing. Enter the linear parameters – intercept and slope – to change one or more of the relationships.

When calculating storage from LOD, neither the LOD proportion, nor is the sum of LOD and SED greater than the reach's volume. This is a necessary simplification given that FFIP-MM does not simulate changes in stream geometry.



Riparian LOD Recruitment

This screen allows you to determine the relationship between the age of the riparian stand and the volume of LOD m^3 per 100m of stream reach (both banks) contributed annually.



Bank Sediment Recruitment

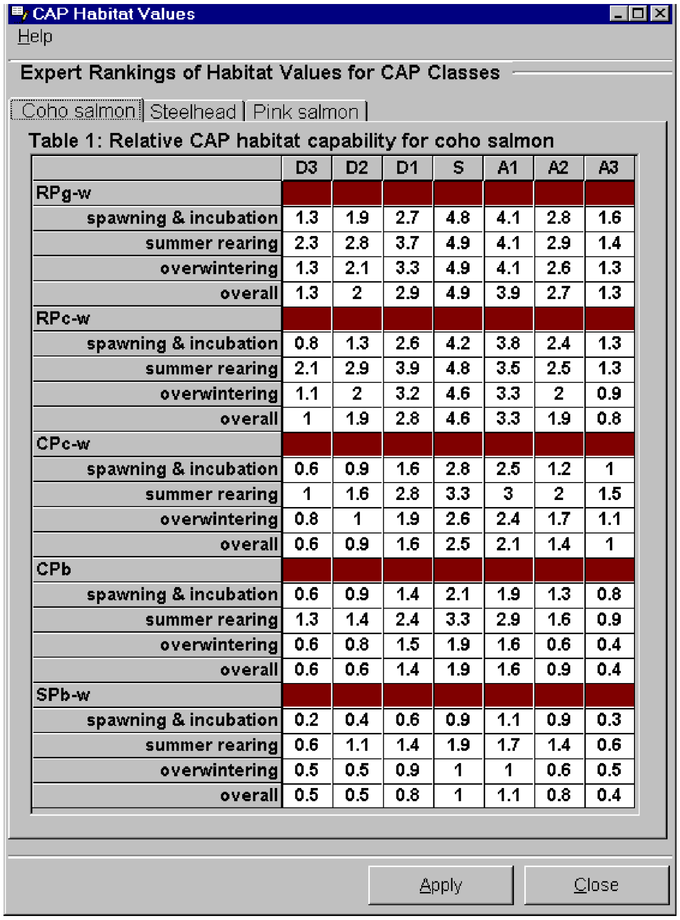
In this dialogue, you enter parameters specifying the rate of recruitment of sediment from stream banks (bank erosion). Different proportions of the net sediment input (that from the adjacent upslope area and that which is passed down from the upstream reaches) can be entered for different CAP state transitions (e.g., stable (S) to slightly aggraded (A1)).

Fish Submodel

From the Main Menu select “Edit|Fish Submodel”.

These tables list expert ratings of fish habitat capability for different life-stages of three species of fish: pink, coho, and steelhead. The ratings are on a scale of 1-5 where 1 is the worst and 5 is the best.

These expert ratings were elicited in a workshop at the University of British Columbia in November 1997. A group of eight fish habitat biologists with extensive field experience assigned fish habitat capacity values to reaches of streams with different CAP types and states. The biologists used colour photographs of example stream reaches with different CAP types and states along with descriptions from the Channel Assessment Procedure Guidebook[9] to make their evaluations.



	D3	D2	D1	S	A1	A2	A3
RPg-w							
spawning & incubation	1.3	1.9	2.7	4.8	4.1	2.8	1.6
summer rearing	2.3	2.8	3.7	4.9	4.1	2.9	1.4
overwintering	1.3	2.1	3.3	4.9	4.1	2.6	1.3
overall	1.3	2	2.9	4.9	3.9	2.7	1.3
RPc-w							
spawning & incubation	0.8	1.3	2.6	4.2	3.8	2.4	1.3
summer rearing	2.1	2.9	3.9	4.8	3.5	2.5	1.3
overwintering	1.1	2	3.2	4.6	3.3	2	0.9
overall	1	1.9	2.8	4.6	3.3	1.9	0.8
CPc-w							
spawning & incubation	0.6	0.9	1.6	2.8	2.5	1.2	1
summer rearing	1	1.6	2.8	3.3	3	2	1.5
overwintering	0.8	1	1.9	2.6	2.4	1.7	1.1
overall	0.6	0.9	1.6	2.5	2.1	1.4	1
CPb							
spawning & incubation	0.6	0.9	1.4	2.1	1.9	1.3	0.8
summer rearing	1.3	1.4	2.4	3.3	2.9	1.6	0.9
overwintering	0.6	0.8	1.5	1.9	1.6	0.6	0.4
overall	0.6	0.6	1.4	1.9	1.6	0.9	0.4
SPb-w							
spawning & incubation	0.2	0.4	0.6	0.9	1.1	0.9	0.3
summer rearing	0.6	1.1	1.4	1.9	1.7	1.4	0.6
overwintering	0.5	0.5	0.9	1	1	0.6	0.5
overall	0.5	0.5	0.8	1	1.1	0.8	0.4

Output Options

From the Main Menu select “Edit|Output Options”. Under this selection, you specify the name and location of the FFIP-MM output database. You also specify how often data are to be printed to the database, and how much of the output to *display* (not to write) at the end of a model run.

[9] **BC Ministry of Environment.** 1996. Forest Practices Code of British Columbia: Channel Assessment Procedure Field Guidebook. Canadian Cataloguing in Publication Data. 97 pp.

Accepting Changes

From the Main Menu select “Edit|Apply All”. Press this button to accept all changes made under the above options, and save these parameters and rates to the *.FIP file.

Note: To use changes made on any of the model’s dialogure screens, you must click “Apply”. Otherwise FFIP-MM will revert to the previous values.

CHAPTER 6

Runs

About Runs

Once you have a prepared *.FIP file and set the model parameters and expert rules, you will want to run the model and examine its results.

A run represents a set of instructions that tells the model how it should execute the scenario. For example, when you define a run, you indicate how many years the model should simulate the scenario and how many times the model should run the same scenario to simulate random slope failure events.

Before running a scenario, you must *ensure that the model has been calibrated to the set of parameters and expert rules you have supplied to the upslope model*. This only needs to be performed once for a given set of parameters and rules. Calibration determines what the equilibrium input rates of sediment and LOD are for your watershed's slope failure characteristics and terrain. This will determine what values of FS and FL would be required to ensure every reach, on average, maintained its pristine CAP state.

Start

After supplying the appropriate instructions under "Run|Options", select "Run|Start". This will start the simulation process. Run options are described below.

Calibration

Calibration determines the long run average inputs of sediment and LOD to streams from slope failures for the watershed in its pristine state. You will want to run the calibration procedure the first time you use a *.FIP file or if you change any of the Upslope parameters. To do this, first enter the number of Monte Carlo trials to use in the text box under “Calibration”. Ensure that the failure check proportion and number of Monte Carlo trials are not significantly different from the values you plan to use at run time. Then select “Run|Calibration”. The calibrated values for each reach’s FS and FL value are then saved to the *.FIP file for use in future model runs.

Note: FFIP-MM will **not** prompt you to calibrate.

Options

Select “Run|Options”. Here you specify the number of Monte Carlo trials and the Start year and End year of a simulation within a Monte Carlo trial. You also specify the number of Monte Carlo trials to use for the calibration procedure. Note: you must use four character years (e.g., 1960). You must also tell FFIP-MM what proportion of the watershed area to check for slope failure (values 0.4 recommended). FFIP-MM weights the probability of failure according to this proportion.

Saving Your Runs

Output from runs is sent to the FFIP-MM database specified under the “Edit|Output” option (see Chapter 5 Scenarios).

Running the Model

Once you have calibrated the model and set the number of years and number of Monte Carlo trials you can run the model scenario. To do this select: “Run|Start”.

A progress bar will be displayed to indicate how far along you are in the scenario.

Note: Turning off “View|Show Graphics” will dramatically improve model performance (speed). This option is discussed under “Dynamic Map Displays” in Part 3.

Part
3

Results

In this section you will learn how to access and graphically display model results using the FFIP-MM database query system.

Part 3 Contents

CHAPTER 7

FFIP-MM Database Structure

During a simulation, FFIP-MM writes output data to the output database you defined in “Edit|Output Options”. You can access this database after a run to view model results. You can also view previous scenario results without the need of re-running that simulation. FFIP-MM has a number of built-in database queries that allow you to view WHC results for three fish species: steelhead, coho, and pink salmon. The database also stores the output information from the Upslope, Channel, and Fish Submodels. Table names correspond to their respective Submodel. The tables below show the variables contained in the FFIP-MM database tables.

Upslope Table

Table 4: Upslope table variables.

Variable	Description
MC Trial	Monte Carlo Trial
Year	Year of simulation
Event	Slope failure event number (for that year and MC trial)
Stream Impacting	Hits stream (true, false)
Reach ID	Reach number
Initial Polygon ID	Forest cover polygon ID
Initial GTC	General Terrain Classification where slide initiates (1 = old growth, 2 = clearcut, 3 = road, 4 = gully)
Initial Age Stand	Age of stand where slide initiates
Multiplier for P (failure)	Drawn from log-normal distribution to represent a year's storm intensity
P (failure)	Probability of slope failure for the slide
Vinit (m^3)	Initial slide volume in m^3
Event Depth (m)	Slide depth (fixed after being drawn from a user-defined normal distribution)
Event Width (m)	Slide width (calculated as) $\frac{Vinit}{Length \times Depth}$
Event Length (m)	Total length of slide path (variable)
Sum of SED Entrain (m^3)	Sum of coarse sediment entrained over length of the debris slide
Sum of LOD Entrain (m^3)	Sum of Large Organic Debris entrained over the length of the debris slide
Sum of SED Depos (m^3)	Sum of coarse sediment deposited over the length of the debris slide
Sum of LOD Depos (m^3)	Sum of Large Organic Debris deposited over the length of the debris slide
Terminal SED Volume (m^3)	Volume of sediment at the end of the debris slide (only positive if it hits a stream)
Terminal LOD Volume (m^3)	Volume of LOD at the end of the debris slide (only positive if it hits a stream)

Channel Table

Table 5: Channel table variables.

Variable	**Description**
MC Trial	Monte Carlo trials
Year	Simulation year
Reach ID	Reach number
CAP State	Channel Assessment Procedure state for a reach (1 = D3; 7 = A3)
FS	Proportion of sediment flushed out of a reach that year
FL	Proportion of LOD flushed out of a reach that year
Multiplier for P(fail), Vinit, SED	Drawn from log-normal distribution to represent a year's storm intensity
Multiplier for LOD	Drawn from log-normal distribution to represent a year's storm intensity (less variance than for P(fail))
Slide LOD In (m^3)	LOD entrained by debris slides entering reach
Riparian LOD In (m^3)	LOD entering reach from riparian tree fall
Upstream LOD In (m^3)	LOD arriving from upstream reaches
LOD In (m^3)	Total LOD from slide, riparian, upstream sources
LOD Out (m^3)	LOD passed downstream to next reach
LOD Stored (m^3)	LOD remaining in the reach at end of year
Slide SED In (m^3)	Sediment input from upslope debris slides
Bank SED In (m^3)	Sediment input from bank erosion
Upstream SED In (m^3)	Sediment arriving from upstream reaches
SED In (m^3)	Total sediment from slide, bank, and upstream sources
SED Out (m^3)	Total sediment moving to next downstream reach
SED Stored (m^3)	Sediment remaining at end of year

Fish Table

Table 6: Fish table variables.

Variable	Description
MC Trial	Monte Carlo trials
Year	Simulation year
Reach ID	Reach number
HC Coho Spawn	Habitat capability for Coho spawners (0-5 scale)
HC Coho Overwinter	Habitat capability for Coho overwintering (0-5 scale)
HC Coho Rearing	Habitat capability for rearing (0-5 scale)
HC Coho Overall	Habitat capability overall (0-5 scale)
HC Steelhead Egg-Fry	Habitat capability for steelhead egg-fry stage (0-5 scale)
HC Steehead Fry-Parr	Habitat capability for steelhead fry-par stage (0-5 scale)
HC Steelhead Parr-Smolt	Habitat capability for steelhead parr-smolt stage (0-5 scale)
HC Steelhead Overall	Habitat capability for steelhead overall (0-5 scale)
HC Pink Egg-Fry	Habitat capability for Pink salmon egg-fry stage (0-5 scale)
CAP State	Reach CAP state
CAP Morphology	Reach CAP morphology

Watershed Habitat Capability (WHC) Rating Table

Watershed habitat capability is the **main focus** of FFIP-MM. FFIP-MM queries obtain and graph WHC for the selection fish species and life stage, and averages over Monte Carlo trials for each year plus or minus one standard error. The WHC frequency distributions that are given contain more information on an individual year than that given by this time series.

Table 7: WHC rating table variables.

Variable	**Description**
MC Trial	Monte Carlo trials
Year	Simulation year
WHC Coho Spawn	Watershed Habitat Capability for Coho Spawners (0-100 scale)
WHC Coho Overwinter	Watershed Habitat Capability for Coho overwinter (0-100 scale)
WHC Coho Rearing	Watershed Habitat Capability for Coho rearing (0-100 scale)
WHC Coho Overall	Watershed Habitat Capability for Coho overall (0-100 scale)
WHC Steelhead Egg-Fry	Watershed Habitat Capability for steelhead egg-fry (0-100 scale)
WHC Steelhead Fry-Parr	Watershed Habitat Capability for steelhead fry-parr (0-100 scale)
WHC Steelhead Parr-Smolt	Watershed Habitat Capability for steelhead fry-smolt stage (0-100 scale)
WHC Steelhead Overall	Watershed Habitat Capability for steelhead overall (0-100 scale)
WHC Pink Egg-Fry	Watershed Habitat Capability for Pink egg-fry stage (0-100 scale)

CHAPTER 8

Viewing Model Results

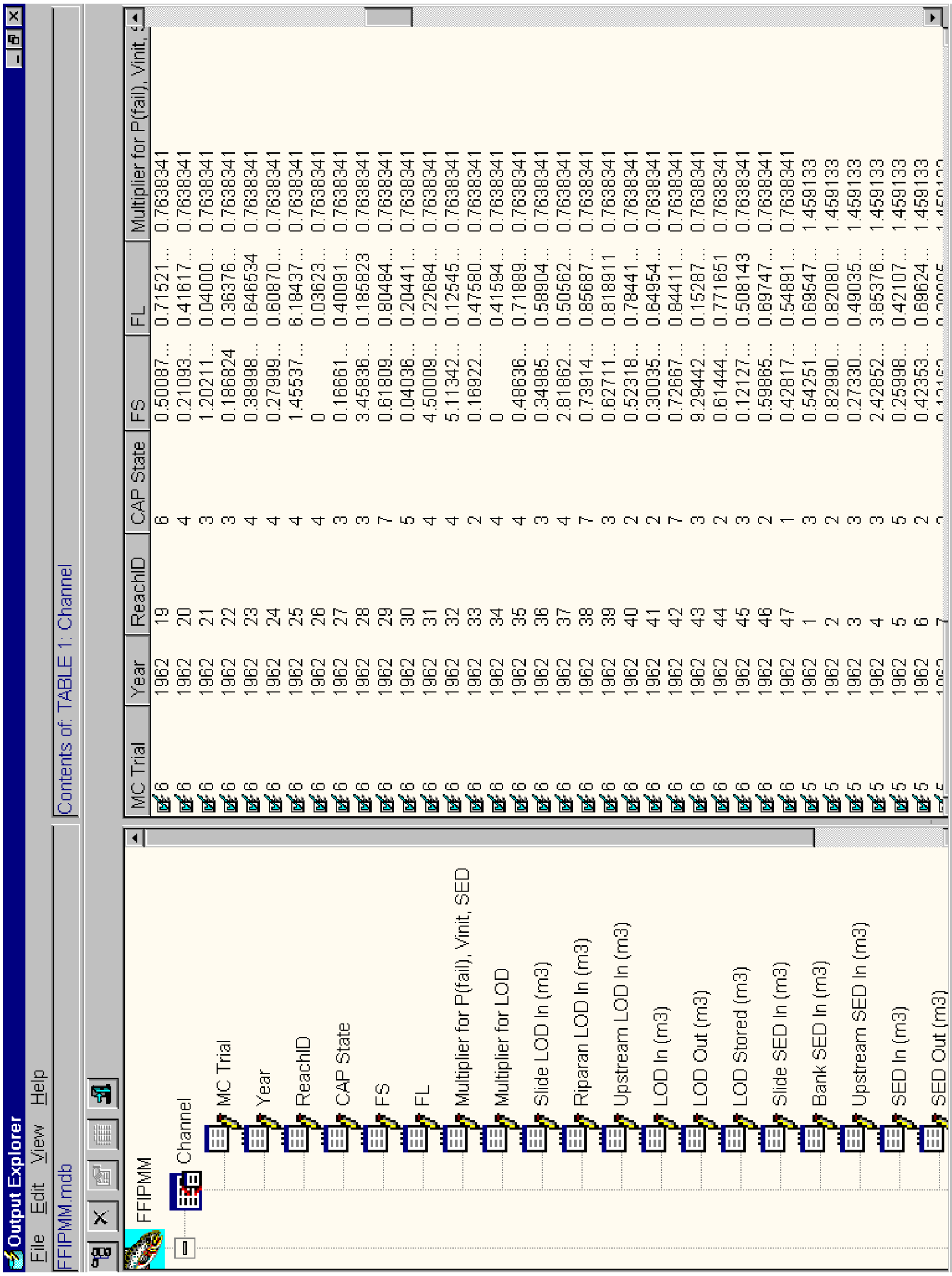
Two Ways to View Model Results

Model results can be viewed in two ways. The primary method is to use FFIP-MM's built-in database queries. For a selected variable, these queries will display a graph of the Monte Carlo average for a particular year and a time-series of Monte Carlo averages over the course of the simulation. Second, you can use MS Access 97 to open the FFIP-MM database and construct your own SQL queries (e.g., to study sediment waves; the model for running just one Monte Carlo trail would permit this as well).

Accessing the FFIP-MM Database

To view the results using FFIP-MM queries select "View|Simulation Output|Explore Output". The Output Explorer window will appear. The FFIP-MM database icon will appear in the left hand pane of the window. Click on this icon to expand the database tables (this control functions "⊞" in much the same way as Windows Explorer). Click on a database table node (not the table name itself) to expand its fields. The fields are the model output variables.

Note: If you left click on the table name, the table will populate the right viewing pane. This can be helpful for viewing table contents, but may take a while to load if the table is large.


Output Explorer
File Edit View Help
FFIPMM.mdb
Contents of: TABLE 1: Channel
FFIPMM
Channel
MC Trial
Year
ReachID
CAP State
FS
FL
Multiplier for P(fail), Vinit, SED
Multiplier for LOD
Slide LOD In (m3)
Riparian LOD In (m3)
Upstream LOD In (m3)
LOD In (m3)
LOD Out (m3)
LOD Stored (m3)
Slide SED In (m3)
Bank SED In (m3)
Upstream SED In (m3)
SED In (m3)
SED Out (m3)
MC Trial | Year | ReachID | CAP State | FS | FL | Multiplier for P(fail), Vinit,
6 1962 19 6 0.50087... 0.71521... 0.7638341
6 1962 20 4 0.21093... 0.41617... 0.7638341
6 1962 21 3 1.20211... 0.04000... 0.7638341
6 1962 22 3 0.186824 0.36376... 0.7638341
6 1962 23 4 0.38998... 0.646534 0.7638341
6 1962 24 4 0.27999... 0.60870... 0.7638341
6 1962 25 4 1.45537... 6.18437... 0.7638341
6 1962 26 4 0 0.03623... 0.7638341
6 1962 27 3 0.16661... 0.40091... 0.7638341
6 1962 28 3 3.45836... 0.185823 0.7638341
6 1962 29 7 0.61809... 0.80484... 0.7638341
6 1962 30 5 0.04036... 0.20441... 0.7638341
6 1962 31 4 4.50009... 0.22684... 0.7638341
6 1962 32 4 5.11342... 0.12545... 0.7638341
6 1962 33 2 0.16922... 0.47580... 0.7638341
6 1962 34 4 0 0.41594... 0.7638341
6 1962 35 4 0.48636... 0.71889... 0.7638341
6 1962 36 3 0.34985... 0.58904... 0.7638341
6 1962 37 4 2.81862... 0.50562... 0.7638341
6 1962 38 7 0.73914... 0.85687... 0.7638341
6 1962 39 3 0.62711... 0.818911 0.7638341
6 1962 40 2 0.52318... 0.78441... 0.7638341
6 1962 41 2 0.30035... 0.64954... 0.7638341
6 1962 42 7 0.72667... 0.84411... 0.7638341
6 1962 43 3 9.29442... 0.15287... 0.7638341
6 1962 44 2 0.61444... 0.771651 0.7638341
6 1962 45 3 0.12127... 0.508143 0.7638341
6 1962 46 2 0.59865... 0.69747... 0.7638341
6 1962 47 1 0.42817... 0.54891... 0.7638341
5 1962 1 3 0.54251... 0.69547... 1.459133
5 1962 2 2 0.82990... 0.82080... 1.459133
5 1962 3 3 0.27330... 0.49035... 1.459133
5 1962 4 3 2.42852... 3.85376... 1.459133
5 1962 5 5 0.25998... 0.42107... 1.459133
5 1962 6 2 0.42353... 0.69624... 1.459133

Viewing Using FFIP-MM Queries

To graph a particular variable, right mouse click over its name. This will display the graph options dialogue box. You will be prompted to provide further information. You must enter the year for which you want to display the Monte Carlo distribution. For variables in the Channel and Fish Tables you must enter the reach numbers of interest. For the Upslope Table, you may be asked whether the results should be calculated for “stream impacting” events or “non-stream impacting” events. The graphs will display the Monte Carlo distribution for a particular year and a time-series graph of the Monte Carlo average over the course of a simulation.

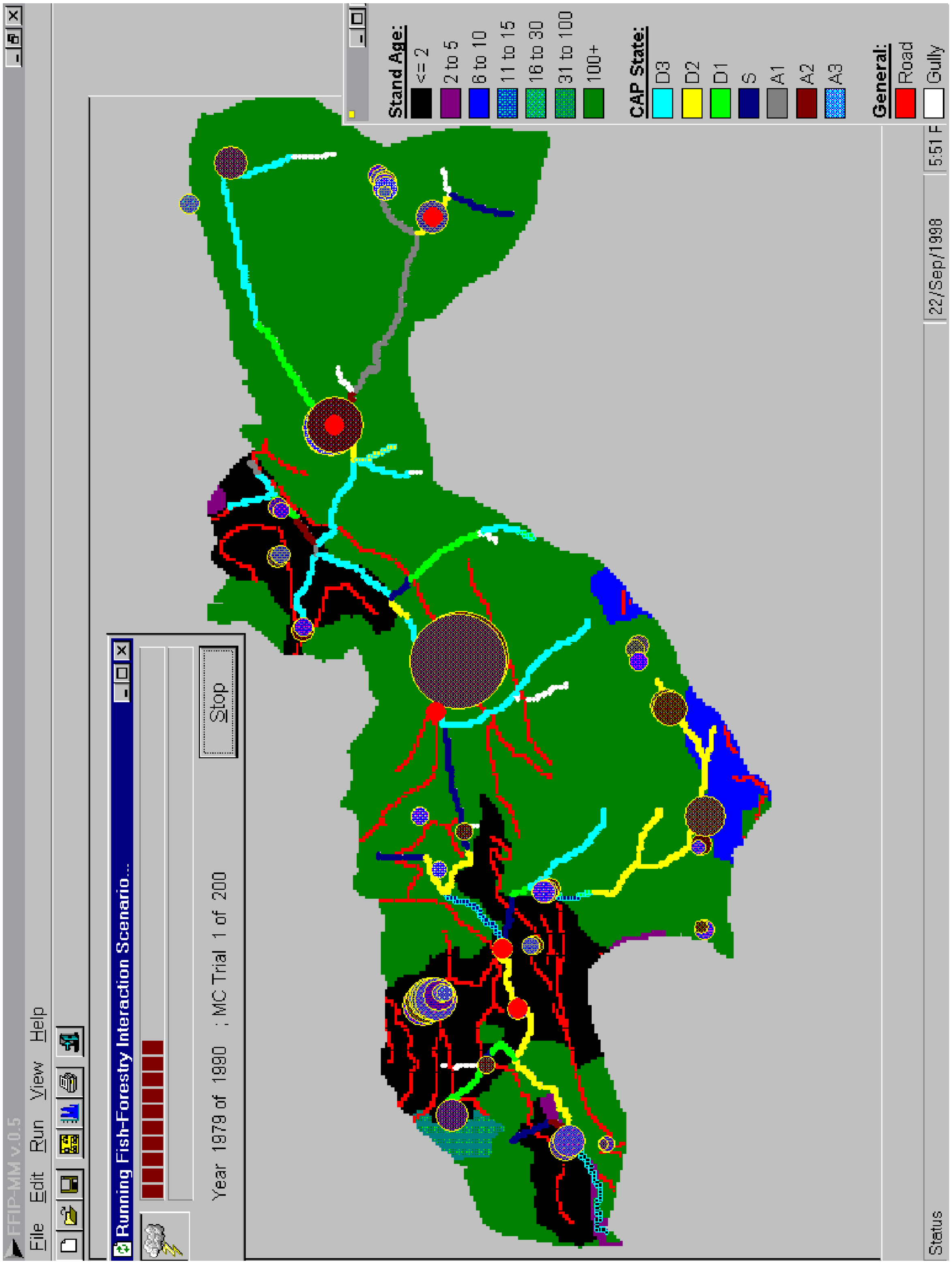
CHAPTER 9

Dynamic Map Displays

FFIP-MM can display run time graphic representations of changes within your watershed over the length of a simulation. When this option is selected, you can watch as roads are introduced to the watershed, the forest age structure changes, watch the trajectories and relative magnitude of slides (a red flashing dot indicates a stream impacting slide), and see reach specific CAP state changes. An example of what this screen looks like is shown below.

FFIP-MM will run much more slowly when this feature is selected. It can be turned on and off during a simulation. To turn this feature on or off select: “View|Show Graphics”.

Note: The dynamic map results for debris slides and CAP states represent those for a single Monte Carlo realization — *not* the average response of the system.


FFIP-MM v.0.5
File Edit Run View Help
Running Fish-Forestry Interaction Scenario...
Year 1979 of 1990 ; MC Trial 1 of 200
Stop
Stand Age:
<= 2
2 to 5
6 to 10
11 to 15
16 to 30
31 to 100
100+
CAP State:
D3
D2
D1
S
A1
A2
A3
General:
Road
Gully
Status
22/Sep/1998
5:51 F