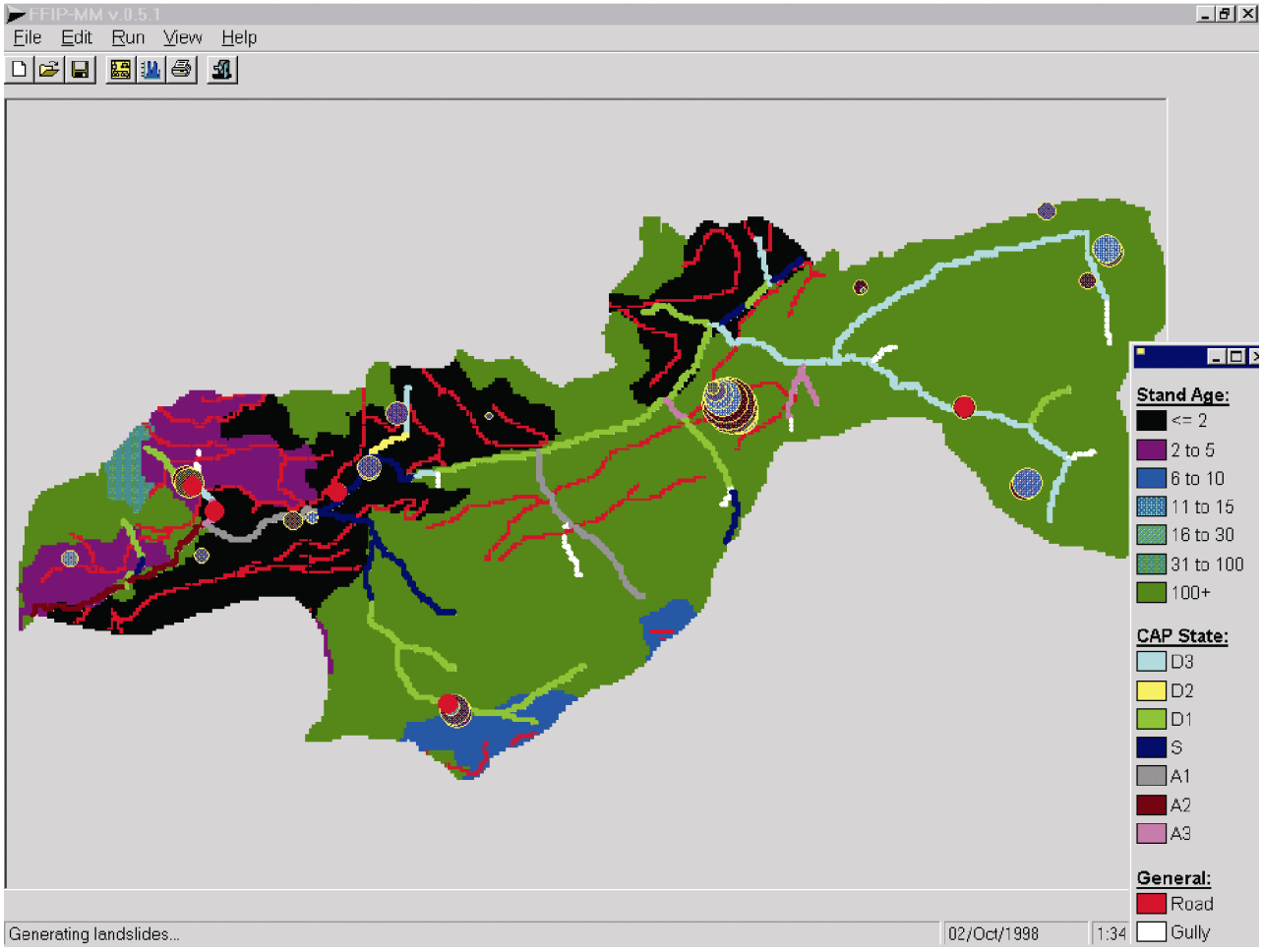
The Fish Forestry Interaction Project – Management Model (FFIP – MM)



What is FFIP – MM?

The Fish Forestry Interaction Program Management Model is a spatially explicit simulation model that for the first time links upslope impacts of forest harvesting on the rate of movement of sediment and large organic debris (LOD) to site specific impacts on fish habitat. It is a user-friendly prototype model suitable for informing coastal watershed management decisions.

FFIP-MM links upslope forest harvesting activities to changes in stream sediment and large organic debris (LOD) transport processes. The rate and magnitude of delivery of LOD and sediment from hillslopes is then related to reach specific impacts for several fish species. This is based on an expert assessment of habitat capability (fresh water survival and productivity) for the 49 different stream morphologies and disturbance states defined under the

Channel Assessment Procedure (CAP) of the BC Forest Practices Code; (BC Ministry of Environment, 1996).[1] During a structured elicitation exercise, expert ratings were developed for coho salmon, pink salmon and steelhead that considered the spawning, rearing and overwintering habitat preferences of each species.

The model has reached a stage of development where it has been applied and tested on one watershed – Carnation Creek in British Columbia. It has a generic structure, however, which allows it to be applied to any coastal watershed with basic terrain and channel assessment information. ESSA is prepared to participate in cooperative research arrangements with Ministry, industry or other groups to apply the model to other watersheds.

What is the purpose of FFIP – MM?

The purpose of FFIP-MM is to provide a tool for evaluating the impacts of alternative harvesting strategies on the value of fish habitat. The tool allows for "what if" gaming, by providing the user control over the magnitude, nature, and distribution of harvesting activities so that the potential impacts of alternative harvesting strategies on fish habitat can be investigated. We believe it can help managers make better management decisions. For example, you could create several alternatives that shared the same set of assumptions about slope failure probabilities, debris flow travel distance, and the current condition of streams, but had different logging road and cut-block locations. You could then examine the output of the alternatives to better understand how the effects of these different logging plans affected the fish habitat capabilities in different parts of the watershed.

The model can answer questions like:

- What are the reach specific and cumulative watershed impacts on fish habitat of timber harvesting?
- 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?

FFIP-MM can be used:

- to assess the range of possible impacts of logging plans on fish habitat capability;
- as a tool for teaching fish-forestry linkages;
- as a tool for communication and increasing scientific understanding;
- for assisting in the design of experiments; and
- to aid in prioritization of inventory efforts.

What are the Data Requirements?

FFIP-MM uses GIS software (ESRI ArcView) to obtain grid representations of the required spatial information. Additional information is provided in an external database (Microsoft Access). The spatial and external data required to apply the model to a given watershed are provided on the following page.

[1] There are seven CAP types (e.g. step pools, cascade pools, riffle-pools) and seven CAP states (i.e., a stable state, three levels of degraded state (D1 to D3), and three levels of aggraded state (A1 to A3).

Spatial Data Requirements
Elevation (m)
Stream reach locations and ID
Gully locations
Logging road locations and the year of construction
Slope stability class (I-V); (BC Ministry of Environment 1995)
Forest Cover polygon locations and ID

External Data Requirements

Forest Cover Information (by stand)
Year of harvest
Mean stand age
Reference year
Site index

Stream Reach Information
Average length, width, depth (m)
Equilibrium CAP type
Initial CAP state
Pristine CAP state
Downstream Reach ID

How does FFIP – MM operate?

FFIP-MM has three major components:

1. an *Upslope submodel* that simulates the probability of slope failure and downslope propagation of sediment and LOD for old growth terrain, clearcuts, gullies and roadbeds;
2. a *Channel submodel* that describes the sediment storage capacity of each reach, and the rate of movement of sediment and LOD through the drainage network; and
3. a *Fish Habitat submodel* that relates the storage of sediment and LOD to an expert rating of habitat value based on CAP (BC Ministry of Environment 1996).

The model accounts for uncertainty in both spatial and temporal components (e.g., where landslides occur; the severity of storm events in a given year). Using Monte Carlo simulation, the model produces probability distributions for fish habitat ratings on a spatially explicit basis through time. These calculations use both explicit physical relationships based on empirical data (e.g., published regressions that estimate changes in slide volume based on slope and other variables (Wise 1997)), as well as expert rules (e.g. proportion standing and downed timber entrained by debris slides).

FFIP-MM completes the following three steps:

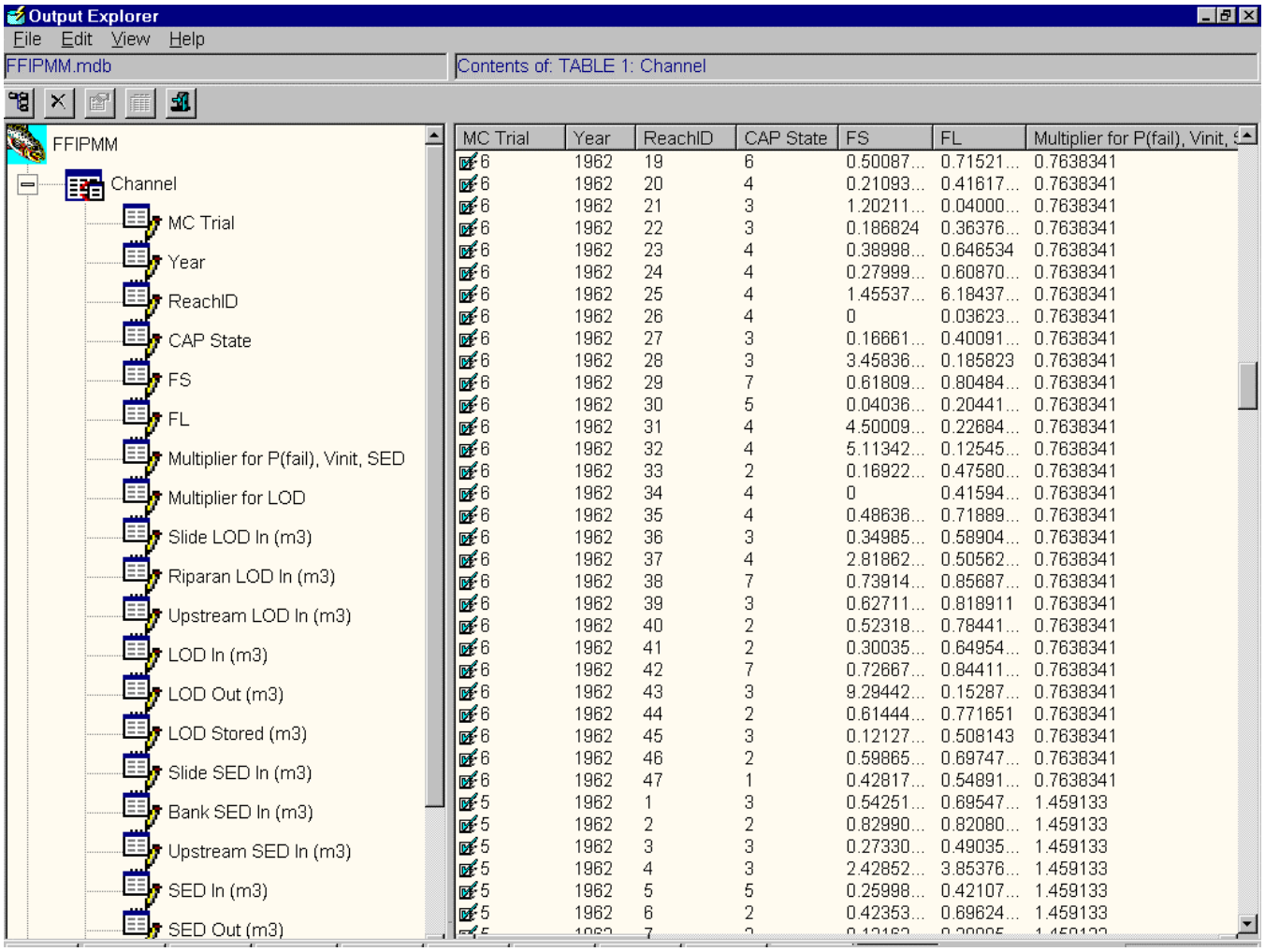
1. *Calibration:* running the Upslope submodel under 'pristine' old-growth conditions to determine the average annual inputs of LOD and sediment from debris slides to each stream reach initialization.
2. *Initialization:* set initial forest age structure, harvest schedule, reach specific CAP types and states, equilibrium (steady state) LOD, and sediment loss rates for each reach.
3. *Simulation:* annually initiate and move sediment and LOD; update CAP states and fish habitat capability for each reach; combine habitat ratings into a watershed habitat capability rating (WHC).

These steps can be repeated to determine the probability distributions of WHC for alternative logging plans.

What output is produced?

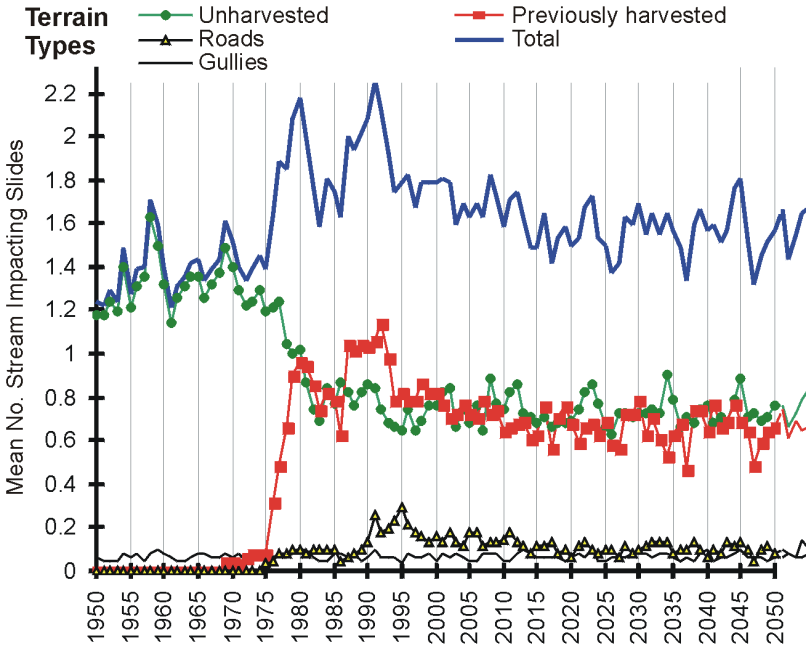
FFIP-MM results can be viewed as maps, graphs, or tables from its user-friendly interface. Since all the results are stored in an external database, users can compare the results of different management alternatives over Monte Carlo runs for different stream reaches, salmon life-history stages, and for the watershed overall.

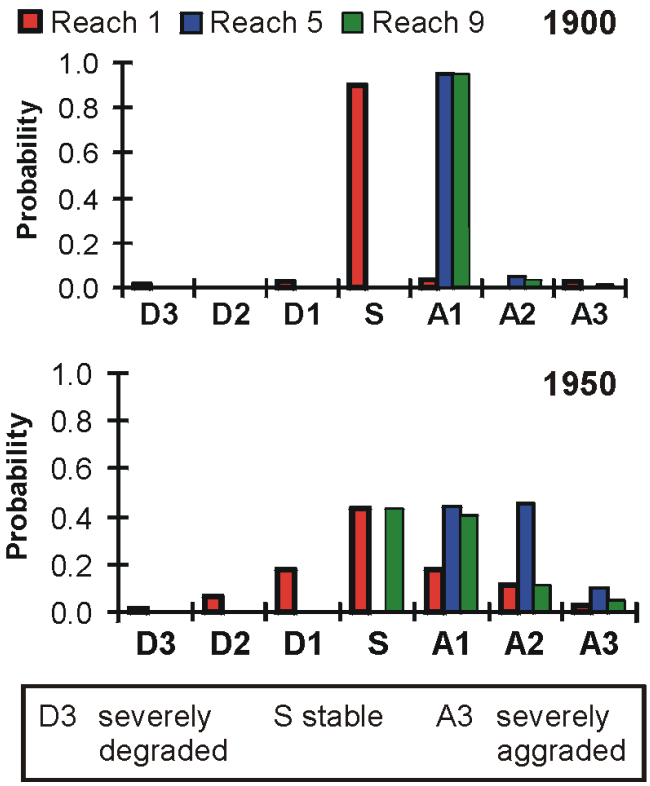
FFIP-MM provides an Output Explorer which allows you to access a number of options for viewing model results.



MC Trial	Year	ReachID	CAP State	FS	FL	Multiplier for P(fail), Vinit, S
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

The Output Explorer allows you to graph a particular variable over time or as a Monte Carlo probability distribution. The graph below illustrates the simulated mean number of stream impacting slides between 1950 to 2100 for four different types of terrain in the Carnation Creek watershed (70 Monte Carlo trials).





FFIP-MM also allows you to display run time maps of changes within your watershed over the length of a simulation. You can watch as roads are introduced to the watershed, the forest age structure changes, watch the trajectories and relative magnitude of the slides, and see reach specific CAP state changes (map on page 1).

You can also display Monte Carlo probability distributions of CAP states for a reach under pristine conditions or for various state variables. The graphs (at left) show this for a Carnation Creek simulation which was started in 1900 and ran until 1950 using 70 Monte Carlo trials.

What documentation is available?

FFIP-MM has a detailed User's Guide that describes the major steps involved in setting up the model, carrying out runs, and analyzing results. Also available is a document providing a more detailed description of the model and its application to Carnation Creek, British Columbia (see Alexander et al. 1998).

What are the system requirements?

The minimum requirements for running FFIP-MM are:

- Pentium class processor, 200 Mhz or better strongly recommended;
- Windows 95, or Windows NT 4.0 or later;
- A 17 inch monitor;
- 64 MB RAM (128 MB is ideal);
- 200 MB hard-disk space; and
- CD ROM drive

How do I get more information on FFIP – MM?

For more information about the use or capabilities of FFIP-MM, please contact:

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ESSA Technologies Ltd. distributes FFIP-MM on a cost-recovery basis (e.g., for photocopying, disk production and postage). In addition, the model developers have extensive experience in running training sessions or workshops to help users adapt the model to different regions.

Acknowledgements

FFIP-MM was developed by ESSA Technologies through a grant from Forest Renewal BC to Steve Chatwin, Dan Hogan and Peter Tschaplinski of the BC Ministry of Forests, with inspired guidance from a dozen academic, government and private sector scientists specializing in fish-forestry interactions.

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