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Developing Fire Management Mixes for Fire Program Planning

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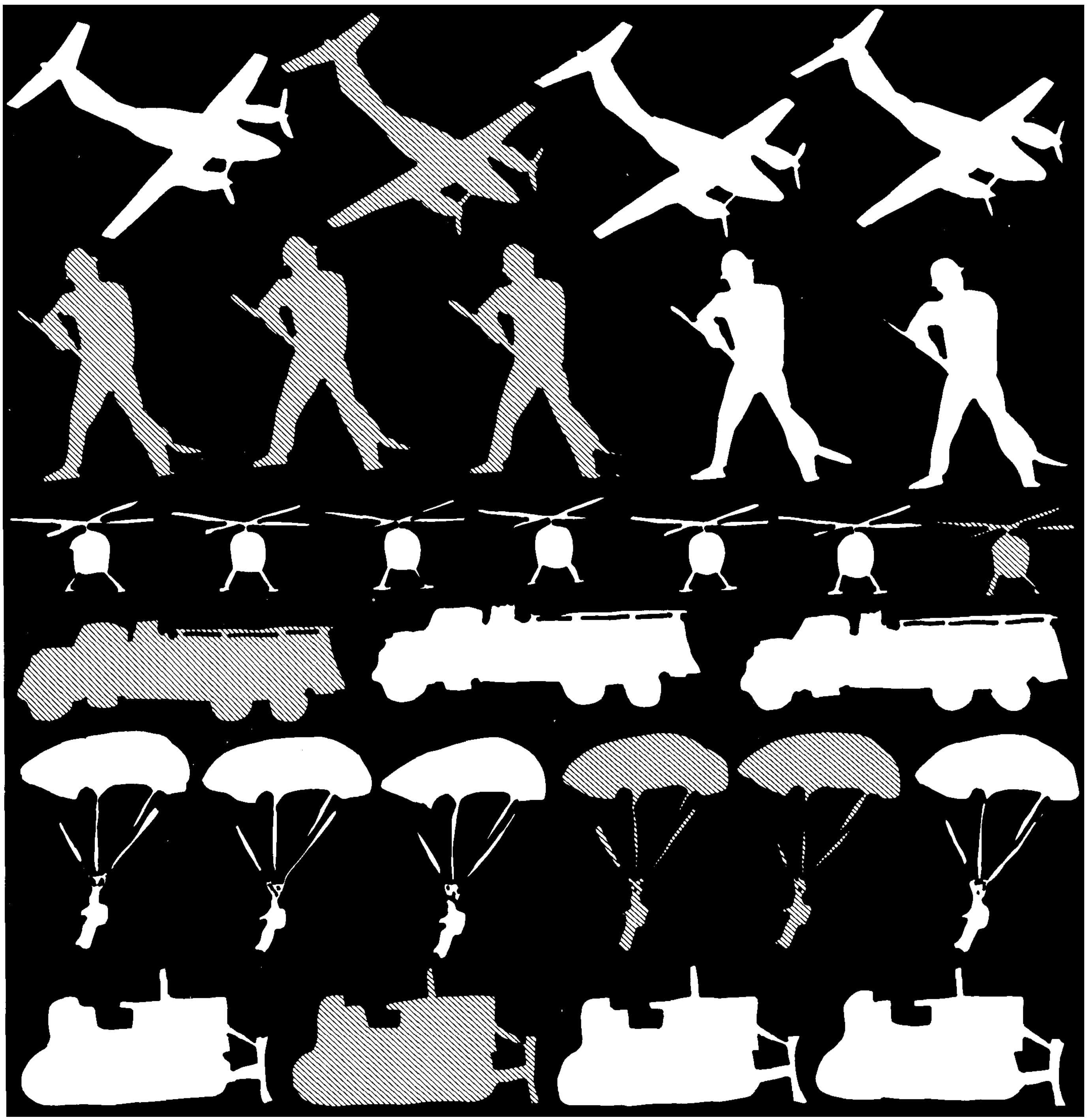

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CONTENTS

INTRODUCTION

Economic efficiency evaluation of fire management program options is vital in the long-term fire management planning process (Oregon State Dep. of Forestry 1972; Schweitzer and others 1982; U.S. Dep. Agric., Forest Serv. 1980, 1982; Winkworth and others 1981). And more and more, economic efficiency is being evaluated through the use of simulation models (Bratten and others 1981; Mills and Bratten 1982; Schweitzer and others 1982; U.S. Dep. Agric., Forest Serv. 1980, 1982), which permit evaluation of a broad range of fire management program options. Information required by such models includes the cost and benefits of all firefighting inputs used, resulting changes in net value of resources, and the combination of inputs that would be needed to execute the fire program being evaluated. The funding levels of fire programs are translated into a combination of firefighting inputs (for example, vehicles, aircraft, bulldozers, and crews) that would be used in the program. Such a combination of particular inputs in certain proportions is a *fire management mix.*

This report describes an algorithm by which the proportions in a fire management mix can be translated automatically into numbers of firefighting inputs available in a specific fire service area. The procedure was originally used in the prototype version of the Fire Economics Evaluation System (FEES), a simulation model being developed by the Forest Service to evaluate program options for nonsite-specific areas (Mills and Bratten 1982) (*appendix*). This report also describes how the concept of fire management mix can be applied to other fire management planning simulation models.

FINDING THE OPTIMUM PROGRAM LEVEL

Cost plus net value change (C + NVC) is the most widely accepted measurement for determining optimal fire management program expenditures (Gorte and Gorte 1979). Although the C + NVC concept has been modified over time, the fundamental concept is still the same: at the optimum program level, the sum of fire protection costs and the value of net change in resources is minimum. That is, the best program level will provide the most fire protection with minimal expenditures, and will result in the least net fire damage (damages minus benefits). Expenditures are combined costs of presuppression (prevention, detection, initial attack, and fuel management), and suppression. As presuppression expenditures increase, for example, net fire damages and suppression expenditures decrease.

Simulation models used in analyzing economic efficiency of fire program options evaluate C + NVC for different combinations of fire management mixes (FMM) and program levels (PL) (Bratten and others 1981; Mills and Bratten 1982; U.S. Dep. Agric., Forest Serv. 1985). A model starts by selecting an FMM. Development of the FMM requires two steps: (1) total program level dollars are allocated to fire program functional activities (prevention, detection, initial attack, and fuel management) through one set of weights (y); and (2) functional activities dollars to be used during the fire season are allocated to specific firefighting inputs (FFI) through a second set of weights (α). The second set of weights represents the emphasis towards different kinds of FFI's, for example, heavy towards ground crews versus air attack. A different set of weights would emphasize different FFI's. Historical ranges of emphases in functional activity indicate ranges of FMM that can be used in evaluating fire program alternatives (*appendix*). The historical program level and distributions of program functional activities dollars should, however, serve only as a guide in the range of alternatives to be evaluated. They should not establish bounds for selection of analysis limits.

A model then simulates a fire season for the planning area selected and derives a C + NVC value for the FMM and PL. Each combination of PL and FMM determines one C+NVC point for a FMM (Mills and Bratten 1982). Theoretically, the curve is U-shaped with the minimum point representing expenditures of the optimum fire management program (*fig. 1*). To obtain other points on the same curve, the PL is varied while the FMM is held constant. The iterative process continues until a point is found at which C + NVC is minimum for the specific curve (local minimum--point A in *fig. 2*). To trace a full C+NVC curve, one of the two parameters involved in the analysis must remain constant. If the FMM and PL are changed at the same time, the same C + NVC curve is no longer being traced. However, the same point may be on two curves that intercept (point Y in *fig. 2*). Increasing PL alone can also trace more than one curve, if a higher PL would allow use of different, more costly firefighting inputs.

A model evaluates FMM's for other PL's until a global C + NVC minimum for the family of C + NVC curves is found (point B in *fig. 2*). The global minimum represents the optimum PL of all PL's and FMM's tested. Because all possible combinations of PL's and FMM's are not evaluated, the minimum

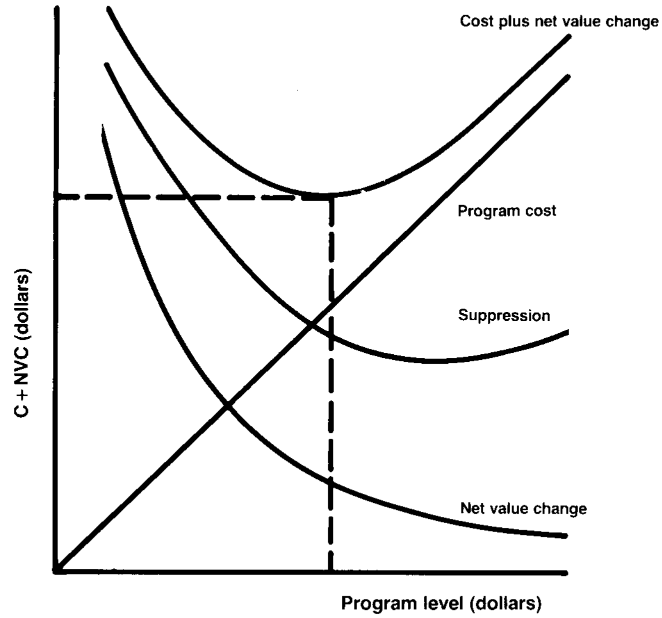

Figure 1--Minimization of the sum of cost plus net value change identifies the optimum fire management program level. The dashed lines indicate the cost plus net value change in dollars and the program level that correspond to the minimum cost plus net value change.

point selected may not necessarily coincide with the theoretical minimum.

The foregone present net worth of a fire program budget constraint can be derived from C + NVC curves. If the fire program level is constrained at PL_1 (*fig. 2*), the foregone present net worth of the fire program option is $(C + NVC)_1 - (C + NVC)_i$. Similar interpretation can be given to nonbudgetary restrictions that lead to the selection of a nonoptimum fire program.

Only initial attack and fuel management functional activities are usually evaluated with current simulation models for two reasons: (1) over 80 percent of total fire program dollars are allocated to initial attack and fuel management; and (2) deriving production functions for prevention and detection is difficult. The procedure described below is for only the initial attack function, although the same process can be used for developing input lists for all other functions.

The cost of the fire function usually covers the training and overhead expenses of nonfire funded personnel who occasionally do fire-related work (e.g., Forest Service regular employees organized in firefighting crews). This cost is charged to the fire function as the availability cost of these crews. Because the number of these crews is assumed to be constant throughout the range of program levels tested, their cost is subtracted from the initial attack program budget. The remaining budget is the amount available for buying other inputs for initial attack. Total dollars allocated to prevention, detection, and fuel management will remain constant for the example presented here so the program level increment goes to only the initial attack function. The procedure is flexible enough to permit increments in all functional areas.

TRANSLATING PROGRAM LEVEL INTO FIREFIGHTING INPUTS

The FMM controls the translation of total PL dollars into a firefighting input list that contains numbers of firefighting inputs. It can be obtained by using a seven-step algorithm (*fig. 3*) modified from the one developed by Hunter (1981).

Step 1: Allocate Program Level Dollars to Functional Activities

$$PL' = PL - \Phi - \Delta \tag{1}$$

$$F_i = PL\,(\gamma i) \tag{2}$$

$$PL' = \sum_i F_i \tag{3}$$

$$\sum_i \gamma_i = 1 \tag{4}$$

in which

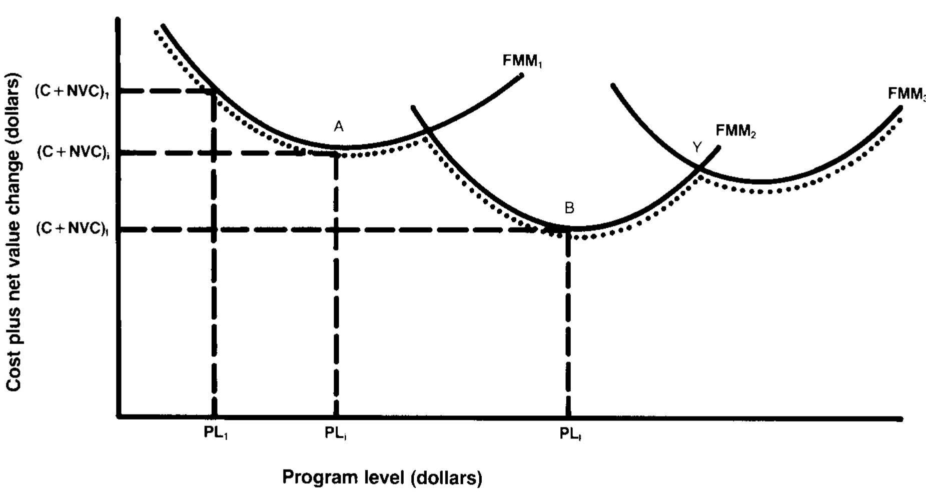

Figure 2--A family of C + NVC curves results from evaluation of several fire management mixes and program levels for a single fire service area. Each curve corresponds to a given fire management mix at a different program level. The dotted line indicates the frontier of greatest efficiency. Point A is a local minimum (for one curve), B is the global minimum (for the family of curves), and Y is a common point on two different curves that intercept.

PL = total fire program dollars for a particular fire service area

PL′ = fire program dollars allocated for the functional activity being evaluated in the model, for example, dollars allocated for initial attack

F_i = total dollars allocated to functional activity i (i = 1, 2, 3, ... 1)

γ_i = percentage of total program dollars allocated to functional activity i

Φ = total dollars of functional activities not evaluated in the model, for example, dollars allocated for prevention, detection, and fuel management

Δ = availability cost for nonfire funded personnel

Step 2: Allocate Functional Activity Dollars to Firefighting Inputs

$$B_{ij} = \alpha_{ij} F_i \tag{5}$$

$$\sum_j B_{ij} = F_i = PL'\gamma_i \tag{6}$$

$$\sum_i\sum_j B_{ij} = \sum_i\sum_j \alpha_{ij}F_i = PL' \tag{7}$$

$$\sum_j \alpha_{ij} = 1 \tag{8}$$

in which

B_{ij} = total dollars allocated to FFI_j

α_{ij} = percentage of F_i allocated to $FF1_j$ (relative weight)

i = functional activity identifier (i = 1, 2, 3, ... I)

j = fire management input identifier (j = 1, 2, 3, ... J)

If only one functional activity was evaluated, i.e., i = 1, then equation 7 would be written as:

$$\sum_j B_{ij} = PL' = PL - \Phi - \Delta$$

Step 3: Translate Dollar Allocation into Physical Units

$$\psi_{ij} = \frac{\alpha_{ij}F_i}{(C_{ij})(W_{ij})(S_{ij})} \cdot \frac{1}{\Omega_{ij}} \tag{9}$$

in which

Ψ_{ij} = number of FFI_{ij} units in the input list

C_{ij} = unit cost per hour of FFI_{ij} (dollars)

W_{ij} = length of workday for FFI_{ij} (hours)

S_{ij} = length of fire season (days)

Ω_{ij} = fraction of total FFI_{ij} cost in the input list paid for by the particular fire service area

The staffing level of operations, the length of fire season, and level of FFI's available from cooperators must be taken into account to develop a realistic input list (IL). An IL is derived using a constant staffing assumption and a fixed fire season for the area evaluated. Constant staffing means that an input will be available for 8 hours of work daily during the fire season. In the planning phase, only the time necessary for the FFI regular tour of duty for the planning period is required.

In some parts of the country, such as Minnesota, in which the fire season is discontinuous, the constant staffing assumption may not be valid. The staffing level and organizational capabilities will most likely differ between the two segments of the season. But because agencies' budgets are allocated at the beginning of their operational year and spent as needed throughout the year, the proposed procedure can still be used. During the planning phase, a constant fire season is assumed and an input list is developed; the availability of the determined input list is then allocated according to the needs of the discontinuous fire season.

Because $\alpha_{ij}F_i = B_{ij}$ and letting $[(C_{ij})(W_{ij})(S_{ij})] = SC_{ij}$ then equation 9 becomes

$$\psi_{ij} = \frac{B_{ij}}{SC_{ij}} \cdot \frac{1}{\Omega_{ij}} \tag{10}$$

in which

SC_{ij} = seasonal cost of FFI_{ij}

In equation 10, when $\Omega_{ij} = 1$, the area under study is paying for the total cost of the FFI's on the list. The probability of getting the input when requested depends on the occurrence of multiple fires within the area. If $\Omega_{ij} < 1$, the area pays only for a fraction of the total cost of the input. In this case, the input list number

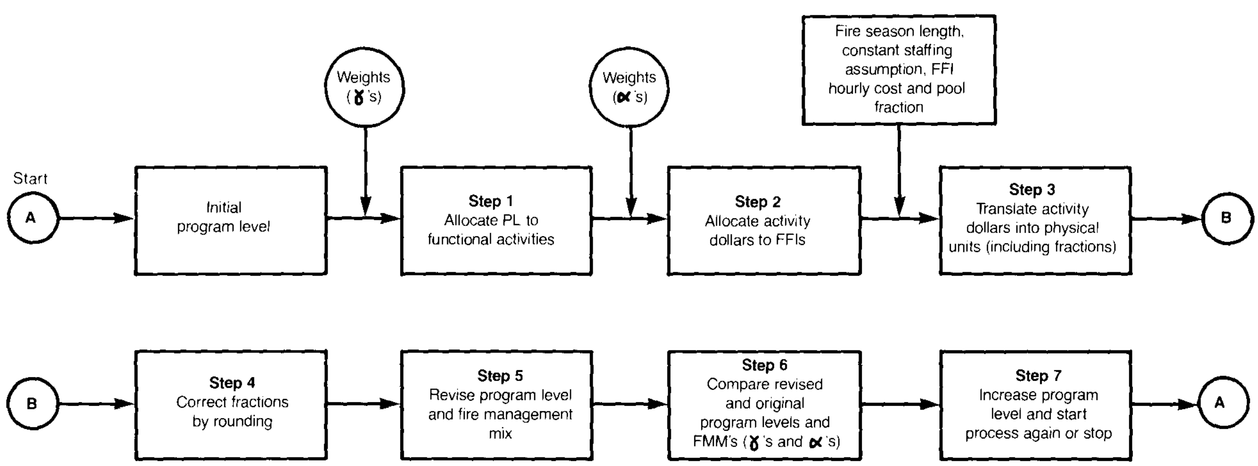

Figure 3--The firefighting input list for a given fire management mix and fire service area can be obtained automatically with a seven-step procedure.

(Ψ_{ij}) represents a pool of shared firefighting inputs from which a service area larger than the area under study is served. The probability of getting an input when requested is a function of multiple fire occurrence in the whole service area and not just in the area requesting the input. The initial attack section of most fire simulation models has a procedure to determine both the probability of multiple fire occurrence and the probability of getting the input requested from a shared pool. Thus far, only three firefighting inputs have been identified as shared between service areas: air tankers, smoke jumpers, and Category I crews.

Current simulation models deal very well with multiple fire occurrence situations between fire service areas, but not with multiple fire occurrence situations within service areas; that is when one subsector of the service area is experiencing multiple fires while the rest of the service area is fire-free. In this case the problem is not one of availability of inputs, but one of time to attack. Most analysts believe that, by and large, the problem of multiple fires falls into this within-service-area category.

The result of the allocation process is the IL or inventory of all the FFI's available to control fires in a particular fire service area:

$$IL = \Psi_{11}, \Psi_{12}, \Psi_{13},\ldots \Psi_{21}, \Psi_{22}, \Psi_{23},\ldots\Psi_{NK} \qquad (11)$$

A perfect divisibility assumption does not necessarily hold in the specific case of firefighting inputs. The problem of lumpiness, (noninteger solutions) occurs because fractional parts of air tankers, water pumpers, or tractors cannot be purchased. The solution obtained by using equations 1 to 11 does not guarantee an integer solution.

As shown in equation 10, solving for Ψ_{ij} will give the number of units of FFI_{ij} purchased with the total dollars allocated to FFI_{ij} (B_{ij}), the FFI_{ij} season cost (SC_{ij}), and the fraction of FFI_{ij} total cost paid by the particular service area (Ω_{ij}).

Let B_{ij} = \$225,000, SC_{ij} = 100,000, and Ω_{ij}= l, and then solve equation 10:

$$\Psi_{ij} = \frac{B_{ij}}{SC_{ij}} \cdot \frac{1}{\Omega_{ij}} = \frac{225{,}000}{100{,}000} \cdot \frac{1}{1} = 2.25 \qquad (12;$$

Given the above conditions, 2.25 units of FFI_{ij} can be purchased. If input j were fire engines (with crews), for example, either 2 or 3 could be purchased.

Step 4: Correct Input Fractions by Rounding

To solve the lumpiness problem, a simple rounding procedure is recommended, i.e., whenever fractions occur in any one of the FFI's on the IL, they will be rounded to the next higher unit if the fraction is greater or equal to 0.5, and rounded to the next lower number if smaller than 0.5.

Step 5: Revise Program Level and Fire Management Mix

After the fractions have been corrected, the dollar amount in the functional activity being evaluated and the program level must be adjusted accordingly to account for the increase (or decrease) in costs and FFI for the fire season. The resulting adjusted input list is equal to

$$IL = U_{11}, U_{12}, U_{13},\ldots U_{21}, U_{22}, U_{23},\ldots U_{NK} \qquad (13)$$

As a result of the integer adjustment, the FMM also needs adjustment. Because of the integer rule, the dollar amount allocated to each functional activity being evaluated and the dollar amount allocated to each FFI within the functional activity may increase or decrease in relation to the original amount. If the amount does increase or decrease, then the proportion (γ_i) of the total dollars allocated to functional activities could change. The proportion (α_{ij}) of the total functional activity dollars allocated to each FFI_{ij} may also change.

Step 6: Compare Revised and Original Levels and Mixes

The new FMM and PL are compared with the original FMM and PL to determine if the same FMM is being measured. If the mean absolute value of the change in the α's from the original to the new FMM is 10 percent or less, the FMM is assumed to be the same. The FMM and PL selected are then evaluated in the simulation model to estimate one point on the C + NVC curve for the fire service area being evaluated.

Step 7: Increase Program Level and Repeat Procedure

The PL is increased and the process is repeated. Changes greater than 10 percent in the mean absolute value of the α's imply that a different FMM is evaluated. In that case, the PL would be increased by a selected amount, and the IL development process would be repeated until the mean absolute value change of the FMM is at or below the 10 percent critical value. If the critical value is not met within 0.90 of the selected increment, the evaluation process begins again at the next program level.

The iterative evaluation process continues until all selected PL and FMM are tested and an IL is derived for each. All PL, FMM, and IL meeting the critical value provide points to estimate a unique C + NVC change curve for a fire service area. The firefighting IL's not meeting the critical value criteria are also printed in a summary table (properly identified) of the program output so they can also be analyzed if managers believe the lists to be representative of the management emphasis identified, such as wilderness area or intensive timber, for the service area evaluated.

Different sets of weights (α_{ij}) can be used for different FMM in different kinds of fire service areas (*table 1*). Personnel with firefighting experience and knowledge of the fire service areas should be consulted about the weights. Certain FFI categories or classes are generally used in the initial attack section of most simulation models (*table 2*).

EXAMPLE APPLICATION

The following example illustrates how the modified algorithm for determining the FFI list can be applied in any particular fire service area. The initial program level is \$1,162,000, and only initial attack will be modeled.

Table I--*Possible weights (percent) for firefighting input types in the initial attack program component*

Fire service areas[1]	Firefighting input types[2]																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	Percent																
Wilderness																	
FMM_1		30			50			20									
FMM_4								10						10	30	30	20
Grasslands																	
FMM_8				10						20		30		20	20		
Noncommercial forests																	
FMM_{10}				20			10		30			20				20	
Commercial forests																	
FMM_{16}	10									20		20		30			20

[1]Only isolated examples are shown. Number of service areas and FMM's (fire management mixes) will vary according to regional characteristics. FMM's will also vary according to their feasibility.

[2]Numbers 1 through 17 correspond to firefighting input types in *table 2*.

Step 1

Allocate program level dollars to functional activities, assuming the following set of weights (γ):

Functional activity	Weight (γ)
Prevention	0.13
Detection	.10
Initial attack	.54
Fuel management	.23

Hold budget levels for prevention, detection, and fuel management functions constant, and increase the program level.

$$PL = (0.13\ PL + 0.10\ PL + 0.54\ PL + 0.23\ PL)$$

$$PL = (151{,}060_{F_1} + 116{,}200_{F_2} + 627{,}480_{F_3} + 267{,}260_{F_4})$$

Translate the program level into an evaluated program:

$$PL' = \$627{,}480_{F_3}$$

Step 2

To allocate functional activity dollars to firefighting inputs, assume three classes of inputs are in the initial attack functional activity: Category I crews, initial attack teams, and medium engines and crews. The same process can be used when developing production functions for the other activities. Using equation 5, allocate the evaluated program budget to the different inputs, using the following weights (a) for the three inputs:

Input	Weight (α)
Category I crews (B_{31})	0.50
Initial attack teams (B_{32})	.25
Medium engines and crews (B_{33})	.25

Use equation 5 to solve for

B_{31} = (0.50) (\$627,480) = \$313,740 B_{32} = (0.25) (\$627,480) = \$156,870 B_{33} = (0.25) (\$627,480) = \$156,870

Step 3

Translate dollar allocation into number of FFI_{ij} units purchased for the season, using equation 10. The following additional information is needed: unit cost of each FFI, length of workday, length of fire season, and the fraction of the pool (Ω_{ij}) paid by the service area. For this example, the workday and fire season length are the same for all inputs in the initial attack, event though in reality, they may differ:

Input	FFI unit cost	Workday	Fire season length	Seasonal cost	Ω_{ij}
	Dollars/ hour	*Hours*	*Days*	*Dollars*	
B_{31}	257	8	100	205,600	0.25
B_{32}	46	8	100	36,800	1.00
B_{33}	55	8	100	44,000	1.00

Use equation 10 to solve for

Ψ_{31} = (\$313,740/\$205,600) 1/.25 = 6.10 Category I crew units

Ψ_{32} = (\$156,870/\$36,800) 1 = 4.26 initial attack teams

Ψ_{33} = (\$156,870/\$44,000) 1 = 3.57 medium engine and crew units

Step 4

To correct fractions in input list, apply the rounding rule. The following input list is obtained: 6 Category I crews, 4 initial attack teams, and 4 medium engines and crews.

Table 2--*Seventeen firefighting input types generally used for initial attack in most simulation models, by category and transportation method*

Category	Transportation method		
		Aircraft	
	Road	Rotary wing	Fixed wing
Personnel teams			
Category I crews	1	2	3
Category II to IV crews	4	5	6
Initial attack team	7		
Helitack team		8	
Smoke jumpers			9
Equipment with personnel			
Tanker-small	10		
Tanker-medium	11		
Tanker-small	12		
Tanker-medium	13		
Retardant			
Rotary wing-small		14	
Rotary wing-medium		15	
Fixed wing-medium			16
Fixed wing-large			17

Table 3--*Original and revised program levels and fire management mixes (results of step 6 for the example application)*

Item	Units	Initial	Revised	Change
Program level comparison				*Pct*
Program level	--	$1,162,000	$1,166,120	0.35
Program budget	--	$ 627,480	$ 631,600	.66
Fire management mix comparison				
Functional activity (y)				
Prevention	--	0.13	0.129	-.30
Detection	--	.10	.099	-.40
Initial attack	--	.54	.541	.31
Fuels management	--	.23	.228	-.48
Firefighting input list (a)				
Category I crew	6	.50	.488	-2.34
Category II crew	4	.25	.233	-6.76
Engine and crew	4	.25	.278	-11.48

Step 5

Revise program level and fire management mix to reflect the increase (decrease) in cost and change in fire management emphasis. The new program level is $1,166,120 and is distributed as follows:

$$PL = (151{,}060_{F_1} + 116{,}200_{F_2} + 631{,}600_{F_3} + 267{,}260_{F_4})$$

F_1 is allocated for prevention, F_2 for detection, and F_4 for fuel management, all of which remain constant in the PL evaluation. To obtain the initial attack total dollars F_3, multiply the number of firefighting units paid for in the adjusted input list (U_{ij}) by the input unit season cost (SC_{ij}) and add overall firefighting inputs by functional activity (eq. 7).

The set of weights (γ) attached to the new PL remains the same. The rounding rule leads to a new set of weights (α) for firefighting input dollar distribution:

$\alpha_{31} = 0.49$, $\alpha_{32} = 0.23$, $\alpha_{33} = 0.28$.

To obtain the new set of γ's and α's (the FMM), divide the functional activity total (F_i) by the new PL total for the γ's ($\gamma_i = PL'/F_i$), and divide the FFI_{ij} total (B_{ij}) by the functional activity total (F_i) for the α's ($\alpha_{ij} = B_{ij}/F_i$).

Step 6

Compare the revised and original program levels and fire management mixes. This comparison shows that the change is less than the critical threshold of 10 percent (*table 3*); therefore, assume the same FMM. After the whole process is completed, the adjusted program level and new fire management mix will be evaluated in the simulation model to trace one point on a C + NVC curve.

Step 7

Increase the fire management program budget to the next program level and repeat the procedure.

For each fire service area evaluated, the following information is needed:

- Initial program level (PL in dollars)
- Availability cost for nonfire funded personnel
- Initial FMM for the functional activities
  - γ_i's (percent)
  - F_i (dollars)
- Initial FMM for each FFI_{ij}
  - α_{ij}'s (percent)
  - C_{ij} (dollars/hour)
  - W_{ij} (hours/day)
  - S_{ij} (days)
  - Ω_{ij} (percent)

CONCLUSIONS

A procedure[1] that automatically translates program budget levels into fire management mixes is described. The algorithm is general enough to be used with any economic efficiency simulation model now in operation for evaluating fire program options. Any organization that needs to determine a list of resources to perform different tasks within separate functional activities can use this procedure; however, it is most efficient when used for planning at the regional, state, or forest level. The number of program levels that can be tested at once is unlimited.

[1]The computer software for this procedure is written in Fortran 77. Information about this program is available from Armando Golzález Cabán, Pacific Southwest Forest and Range Experiment Station, 4955 Canyon Crest Drive, Riverside, CA 92507.

APPENDIX: FIREFIGHTING INPUT LISTS

To test the Forest Service's Fire Economics Evaluation System (FEES), we developed three lists of firefighting inputs. The different lists show the range of fire management mixes with emphasis on (A) historical program levels, (B) use of air attack rather than ground crews, and (C) use of ground crews rather than air attack. The distributions of the firefighting inputs in the lists represent the percentage of the initial attack program dollars used for the different firefighting inputs after subtracting a fixed amount to cover the availability cost of 3 nonfire funded Category II crews and 17 project crews. Other presuppression expenditures were held constant as follows: prevention--$86,190, detection--$53,040, fuel management--$125,970.

A--Historical Emphasis

Firefighting inputs	Historical[1]		Historical minus 50 pct[2]		Historical plus 50 pct[3]		Historical plus 100 pct[4]	
	No.	Distribution	No.	Distribution	No.	Distribution	No.	Distribution
		Percent		*Percent*		*Percent*		*Percent*
Category II crew	3		3		3		3	
Project crew	17		17		17		17	
Category I crew	1	0.10	1	0.22	2	0.12	2	0.09
Helitack (5 teams and helicopter)	1	.29	0	.00	2	.33	2	.26
Engines--small	3	.15	2	.22	5	.15	7	.16
Engines--medium	2	.15	I	.16	3	.13	5	.17
Bulldozer--medium	1	.05	I	.10	2	.05	2	.04
Airtanker--medium	3	.05	2	.06	5	.04	8	.05
Jumpers (4 teams and aircraft)	2	.21	1	.24	3	.18	5	.23
Total	33	---	28	---	42	---	51	---

[1]Program level--$661,619, initial attack--$396,419. [2]Program level--$489,101, initial attack--$223.901.
[3]Program level--$903,550, initial attack--$638,351. [4]Program level--$1,066,935, initial attack--$801,736.

B--Air Forces Emphasis

Firefighting inputs	Historical[1]		Historical minus 50 pct[2]		Historical plus 50 pct[3]		Historical plus 100 pct[4]	
	No.	Distribution	No.	Distribution	No.	Distribution	No.	Distribution
		Percent		*Percent*		*Percent*		*Percent*
Category II crew	3		3		3		3	
Project crew	17		17		17		17	
Category I crew	0	0.00	0	0.00	1	0.06	1	0.04
Helitack (5 teams and helicopter)	2	.57	1	.58	3	.51	4	.50
Engines--small	0	.00	0	.00	0	.00	0	.00
Engines--medium	1	.08	1	.15	2	.09	3	.10
Bulldozer--medium	0	.00	0	.00	0	.00	0	.00
Airtanker--medium	3	.04	2	.06	5	.04	8	.05
Jumpers (4 teams and aircraft)	3	.31	1	.21	5	.30	7	.31
Total	29	---	25	---	36	---	43	---

[1]Program level--$666,083, initial attack--$400,883. [2]Program level--$501,197, initial attack--$225,997.
[3]Program level--$892,822, initial attack--$627,623. [4]Program level--$1,091,847, initial attack--$826,648.

C--Ground Forces Emphasis

Firefighting inputs	Historical[1]		Historical minus 50 pct[2]		Historical plus 50 pct[3]		Historical plus 100 pct[4]	
	No.	Distribution	No.	Distribution	No.	Distribution	No.	Distribution
		Percent		*Percent*		*Percent*		*Percent*
Category II crew	3		3		3		3	
Project crew	17		17		17		17	
Category I crew	1	0.10	1	0.20	2	0.13	3	0.13
Helitack (5 teams and helicopter)	0	.00	0	.00	0	.00	0	.00
Engines-small	7	.36	4	.41	11	.35	16	.37
Engines-medium	5	.38	2	.30	7	.33	11	.37
Bulldozer-medium	1	.05	1	.09	2	.06	2	.04
Airtanker-medium	0	.00	0	.00	0	.00	0	.00
Jumpers (4 teams and aircraft)	1	.11	0	.00	2	.13	2	.09
Total	35	---	28	---	44	---	54	---

[1]Program level--$660,162, initial attack--$394,962. [2]Program level--$503,634, initial attack--$228,434.
[3]Program level--$856,794, initial attack--$591,594. [4]Program level--$1,070,057, initial attack--$804,858.

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Evaluating economic efficiency of fire management program options requires information on the firefighting inputs, such as vehicles and crews, that would be needed to execute the program option selected. An algorithm was developed to translate automatically dollars allocated to type of firefighting inputs to numbers of units, using a set of weights for a specific fire service area. Solutions that call for fractions of inputs are resolved by a set of rules on rounding out values. The procedure is general enough to be used with any economic efficiency simulation model for evaluating fire program options; however, it is most efficient when used for planning at the regional, state, or forest level.

Retrieval Terms: fire management mix, firefighting inputs, cost plus net value change

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