

Analysis of Forest Service Wildland Fire Management Expenditures: An Update¹

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Abstract

Soaring expenditures for fire management in the USDA Forest Service have caused substantial concern over fire management costs, especially in light of questions about the role of fire in ecosystems. This report contains analysis of most Forest Service fire management expenditures between fiscal years 1970-98. Expenditure information was obtained from a variety of sources, including electronic files from the National Finance Center, hardcopy information from archived records, and data developed by regional fire and accounting personnel. Results identified statistically significant trends in increased total fire management expenditures, in both nominal and real dollars, with or without the fiscal year 1994, the record expenditure year. When expressed in constant 1998 dollars, fire preparedness expenditures showed a statistically significant compound growth rate of 3.4 percent annually, while no trend could be discerned for fire operations expenditures. Similarly, no statistical trend in annual fuel treatment expenditures could be detected over the fiscal years 1970-98 period, although a statistically significant compound growth rate of 20.1 percent annually was found for the 1990's.

Fire prevention and control have always been important to the mystique of forestry and the USDA Forest Service. Everyone knows of Smokey Bear and envisions smokejumpers parachuting to fires. But more recently, questions have been raised about the role of fire in ecosystems and the enormous costs of fire control. Seemingly, the costs of control are out of control. Expenditures in fiscal year (FY) 1994 caused considerable concern.

In FY 1994, the expenditures for Forest Service fire management reached a record-breaking total of nearly \$1 billion. Because of these soaring expenditures for fire management, and the recommendations of the *Strategic Assessment of Fire Management* report (USDA Forest Service 1995) to address them, the Fire Economics Assessment Team was chartered by Forest Service, Fire and Aviation Management (FAM) staff in 1995. The Team was charged to review current fire management expenditures and their trends and identify opportunities to reduce them. The Team's report was submitted during September 1995 (Bell and others 1995) and later published in an abbreviated format (Schuster and others 1997).

This paper summarizes some of the Fire Economics Assessment Team's fire expenditure information, which has been updated to include expenditures from the FY 1998 fire season.

Methods

This assessment focused on fire management expenditures under the control of the Fire and Aviation Management (FAM) staff in Washington, D.C. (WO) within the Forest Service. These expenditures are an understatement of total fire management expenditures on National Forests or for the Forest Service for two main reasons. First, FAM is not the only area within the Forest Service performing fire management activities. For example, timber managers conduct fuels improvement by using brush-disposal funds collected from timber sales. Second, agencies other than the Forest Service fight fires on National Forests, for which partial or no reimbursement is made. For example, when military personnel fight fire on National Forests, the Forest Service reimburses for expenditures above basic expenses only. When a USDI agency, such as the Bureau of Land

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Management, fights fire on National Forests, there is no transfer of funds. Similarly, there is no transfer of funds when Forest Service personnel fight fire on USDI lands.

Information on fire expenditures attempted to describe expenditures under control of FAM for Forest Fire Preparedness (formerly called Fire Protection) and Fire Operation activities (formerly called Fighting Forest Fires). This was done over time (FY 1970-98) and space (by Forest Service regions) in both nominal and constant 1998 dollars. We focused on standard Forest Service administrative regions: Northern Region (R-1), Rocky Mountain Region (R-2), Southwestern Region (R-3), Intermountain Region (R-4), Pacific Southwest Region (R-5), Pacific Northwest Region (R-6), Southern Region (R-8), Eastern Region (R-9), and the Alaska Region (R-10); the Washington Office and affiliated units were designated as R-13+. Analysis of data was limited to simple descriptive statistics (e.g., mean and standard deviation) and regression analysis of time series to determine the efficacy of a compound growth trend.

Data Collection

Information about fire expenditures came from several sources, but all basically derived from official Forest Service accounting records, the "statement of obligations" produced through the National Finance Center. Data collected can be divided into aggregates of years. FY 1970-88 data were mainly to have been provided through the Forest Service WO Fiscal and Accounting Services (FAS) staff. When available, those records were copied from archived original records stored in the WO. Once received, appropriate information was entered into data-entry and data accumulation spreadsheets developed by Rocky Mountain Research Station (RMRS) personnel. In several cases, FY 1983-88 records did not exist and had to be obtained through an iterative process of contacting regional-level fiscal personnel. FY 1989-98 information was provided electronically by the WO-FAM staff, with the assistance of regional fiscal management specialists. Information received was in the form of electronic files, which were converted to the RMRS spreadsheet format.

Data Structure

The format of fire expenditure records has changed over time. Expenditure categories (currently referred to as "work activities") became more and less detailed, and budget accounts (currently referred to as "fund codes") varied between 1- and 2-year appropriations and were controlled by Fire and Aviation Management and/or Timber Management. General Administration (GA) expenditures were included in fire management appropriations in some years and appropriated separately in others. Nevertheless, this study always focused on two broad appropriations: Fire Preparedness and Fire Operations.

Changes in the accounting system required construction of a "cross-walk" to ensure uniformity and consistency from year to year (*table 1*). Specifically, personnel from RMRS and WO-FAM developed the crosswalk for FY 1994-98; WO-FAM developed FY 1989-93; and RMRS, WO-FAS and R1-FAS developed FY 1970-88. Because the content and specificity of work activities changed over time, they were aggregated into broad categories:

- Fire Preparedness: Presuppression
 - Fuels
 - Reimbursable expenses
 - Other

- Fire Operations:
 - Suppression
 - Rehabilitation
 - Severity
 - Economic efficiency
 - Fuels
 - Reimbursable expenses
 - Other

For example, fund codes pertaining to Fire Preparedness were 002P&M (protection and maintenance) in FY 1970 (then referred to as appropriation codes) and 701FP (fire protection) in FY 1987. Similarly, work activity codes 101 and 102 contained presuppression expenditures in FY 1970 (then referred to as major functions) and 102 and 111 in FY 1987. The broad categories did not always exist (*table 1*). For example, economic efficiency began with FY 1993; severity began with FY 1987; rehabilitation began with FY 1977; and fuels improvement was distinguished from general presuppression expenditures in FY 1977. Reimbursable expenses are expenses initially paid for by the Forest Service but are later reimbursed by another agency, most notably a state fire-fighting agency; as such they are only temporary expenses and are shown but not included in totals.

Missing Data and Verification

Unfortunately, available accounting records were not always complete and our attempts to use other data sources were not always successful. As a result, in some instances, RMRS personnel estimated fire expenditure data. In many cases, the process of estimating missing data was linked to data verification.

Fire expenditure data were verified both internal to data collection and by external sources. Internally, statement of obligation records came in two formats. In the fund code by work activity (e.g., BUDG4V-3), the statement of obligation showed a fund code total which could be used to verify that data had been correctly entered. In the work activity by fund code (e.g., BUDG4V-5) format, there was no fund code "check total," and we could only inspect data entries for errors; if we could detect that work activity information was missing, they were treated as missing, and regional personnel (both fiscal and fire) were contacted to secure needed records. External verification came from a variety of sources, records, and reports.

Even after extensive efforts to secure all needed data, some could not be secured. We were able to obtain virtually all data for R-1, R-2, and R-3 and most data for R-4, R-6, R-8, R-9, and R-10. R-5 and R-13 (the WO) had the most missing data, with R-13 being, by far, the worst. Missing data were specified in four ways. First, some missing values could be deduced, as when the preceding and succeeding values for a particular work activity was zero. Second, some fund code totals (e.g., R-5 fire operations in FY 1980) were estimated by assuming the same pattern of change as in adjacent regions (e.g., R-3, R-4, and R-6 for missing R-5 values), or by assuming a percentage share for the missing year (e.g., R-6 fire protection expenditures in FY 1981 and FY 1982 were assumed to be 6 percent of the national total because they were that in FY 1980 and FY 1983). Third, in some cases all data were known, except for the missing observation; in that case, the missing observation was deduced as the residual. This approach was used extensively for R-13 (WO), for which there was virtually no expenditure information from FY 1980 through FY 1988. Fourth, in FY 1998, R-6 and R-10 were "pilot" sites for testing the proposed Federal Financial Information System (FFIS), but HIS did not perform adequately and could not provide expenditure information at the work activity level. Consequently, we apportioned total FY 1998 expenditures to work activities based on the FY 1997 distribution of expenditures by work activities.

Table 1-Fund codes and work activity codes for classes of wildland fire management expenditures.

Fiscal year	Fire Preparedness (formerly Forest Fire Protection)					Fire Operations (formerly Fighting Forest Fires)								
	Fund codes	Work activity classes				Fund codes	Work activity classes							
	Presuppression	Fuels	Reimburseable Expenses	Other		Suppression	Rehabilitation	Severity	Economic efficiency	Fuels	Reimburseable Expenses	Other		
1970	002P&M	101, 102	---	312,313	320	003FFF	101, 102, 103	-	---	---	312, 313	---		
1971	102P&M	101,102	---	312,313	320	103FFF	101, 102, 103	-	---	---	312, 313	---		
1972	202P&M	101,102	---	312,313	320	203FFF	101, 102, 103	-	---	---	312, 313	---		
1973	302P&M	101,102	---	312,313	320	303FFF	101, 102, 103	-	---	---	312, 313	---		
1974	402P&M	101,102	---	312,313	320	403FFF	101, 102, 103	-	---	---	312, 313	315		
1975	502P&M	101,102	---	312,313	320	503FFF	101, 102, 103	-	---	---	312, 313	315		
1976	602	101,102	---	312,313	320	603	101, 102, 103	-	---	---	312, 313	180, 315		
1976TQ ¹	102	101,102	---	312,313	320	103	101, 102, 403	-	---	---	312, 313	180, 315		
1977	701	111 to 114, 116, 920s, 930s	115	312,313	173,180,960+	703	102, 111 to 116	094	---	---	312, 313	180		
1978	801	111 to 114, 116, 920s, 930s	115	312,313	173,180,960+	803	102, 111 to 116	094	---	---	312, 313	180		
1979	901FM	102, 110 to 114, 116, 920s, 930s		312,313	173, 180, 311, 316,960+	903FFF	102, 110 to 116	094	---	---	312, 313	180, 316		
1980	00IFFP	102, 111 to 114	115	312,313	311,316	003FFF	102	092	---	---	312, 313	316		
1981	101FFP	102, 111 to 114	115	312,313	311,316	103FFF	102	092	---	---	312, 313	316		
1982	201FFP	102, 111 to 114	115	312,313	311,316	203FFF	102	092	---	---	312, 313	316		
1983	301FP	102, 111 to 114	115	312,313	311,316	303FFF	102	092	---	---	312, 313	316		
1984	401FP	102, 111 to 114	115	312,313	311,316	403FFF	102	092	---	---	312, 313	316		
1985	501FP	102, 111 to 114	115	312,313	311,316	503FFF	102	092	---	---	312, 313	316		
1986	601FP	102, 111 to 114	115	312,313	311,316	603FFF	102	092	---	---	312, 313	316		
1987	701FP	102,111	115	312,313	311	703FFF	102	092	111	---	312, 313	316		
1988	8NFAF	PF11s, PF12	PF2s	TSs	ETs, GMs, MLs, PLs	8NFFF8	PF12s	FWs	PF11s	---	TSs	ATs, TSs		
						8NFFF9	PF12s	FWs	PF11s	---	TSs	ATs, TSs		
1989	9NFAF	PF11s, PF12	PF2s	TSs	ETs, GMs, MLs, PLs	9NFFF9	PF12s	FWs	PF11s	---	TSs	ATs, TSs		
						9NFFF0	PF12s	FWs	PF11s	---	TSs	ATs, TSs		
1990	0NFAF	PF11s, PF12	PF2s	TSs	Others	0FFFS0	PF12	FWs, ATs, LTs	PF11s	---	TSs	Others		
	0FFFP	PF11s, PF12	PF2s	TSs	Others	0FFFS	PF12		PF11s	---	TSs	Others		
1991	FFFP	PF11s, PF12	PF2s	TSs	Others	FFFS	PF12	FWs, ATs, LTs	PF11s	---	TSs	Others		
1992	FFFP	PF11s, PF12	PF2s	TSs	Others	FFFS	PF12	FWs, ATs, LTs	PF11s	---	TSs	Others		
						EFFS	PF12	FWs, ATs, LTs	PF11s	---	TSs	Others		
1993	FFFP	PF11s, PF12	PF2s	TSs	Others	EFFS	PF12	FWs, ATs, LTs	PF11s	PF114	---	TSs		
1994	FFFP	PF11s, PF12	PF2s	TSs	Others	EFFS	PF12	FWs, ATs, LTs	PF11s	PF114	---	TSs		
1995	FFFP	PF11s, PF12	PF2s	TSs	Others	EFFS	PF12	FWs, ATs, LTs	PF11s, PF115	PF114	---	TSs		
1996	WFPR	PF11s, PF12	PF2s	TSs	Others	WFSU	PF12	FWs, ATs, LTs	PF11s, PF115	PF114	---	TSs		
1997	WFPR	PF11s, PF12	PF2s	TSs	Others	WFSU	PF12	FWs, ATs, LTs	PF11s, PF115	PF114	---	TSs		
1998	WFPR	PF11s, PF12	---	TSs	Others	WFSU	PF12	FWs, ATs, LTs	PF11s, PF115	PF114	---	TSs		

¹ TQ = transition quarter, July-September, 1976

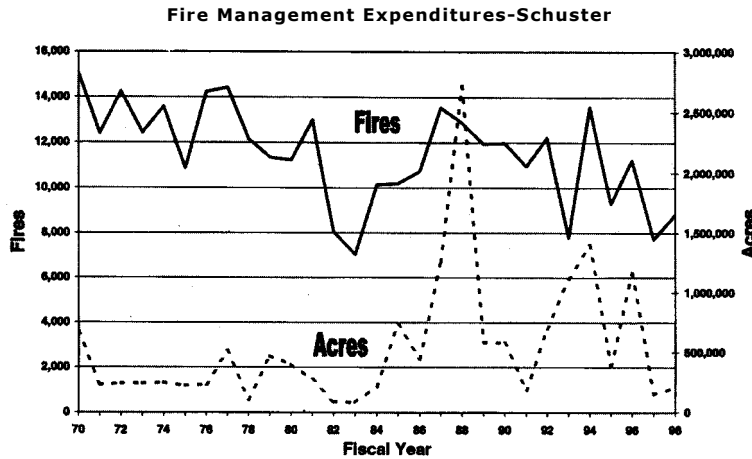


Figure 1
Number of fires and acres burned, FY 1970-98, by year.

Results

FY 1994 did not have the largest number of fires, nor were the most acres burned. Over the FY 1970-98 period, the largest number of fires occurred in FY 1970, when there were more than 15,000 ignitions; FY 1994 ranks fifth, with 13,575 fires (*fig. 1*). Over time, the number of fires has been dropping. The average number of fires annually during the first early years (FY 1970-74) was 13,542, which decreased to an average of 10,122 fires per year during the later years (FY 1994-98). The annual number of fires showed a statistically significant ($p = 0.00$) compound growth rate of about -1.2 percent annually. The most acres burned in FY 1988, when more than 2.7 million acres burned; FY 1994 ranked second, with almost 1.4 million acres. Although the number of fires has been declining, the acreage burned has been increasing. During FY 1970-74, an average of 325,106 acres was burned annually, and by FY 1994-98 the annual average had risen to 661,860 acres. The annual acres burned showed a statistically significant ($p = 0.09$) compound growth rate of about 3.3 percent per year. However, FY 1994 is important because it ranks first in expense; it was the most expensive year on record, exceeding the previous record (FY 1988) by 56.9 percent. Fire management expenditures in FY 1994 prompted this assessment.

Overall Expenditures

This assessment of fire management expenditures covers the time period FY 1970-98. Over this period, the Forest Service spent about \$9.6 billion on fire management activities. Fire management expenditures amounting to \$56 million in FY 1970 rose to nearly \$1 billion by FY 1994, a seventeenfold increase (*fig. 2*). The FY 1970-74 annual average of \$100 million rose to an annual average of \$659 million during the period FY 1994-98. Annual expenditures rose at a statistically significant ($p = 0.00$) compound growth rate of 7.4 percent annually. The infamous 1988 fire season was expensive (\$592 million), but not nearly as expensive as the record year of FY 1994, when \$944 million were spent.

Measuring total fire management expenditures in constant 1998 dollars adjusts for inflation, which holds the purchasing power of money constant (*fig. 2*). In

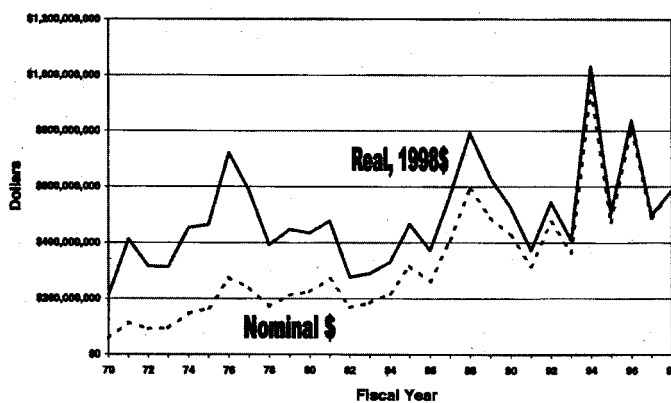


Figure 2
Total fire management expenditures, FY 1970-98, by year.

constant dollars, FY 1994 at \$1.032 billion was still the record year, followed by FY 1988 at \$793 million, and FY 1976 (a 15-month year) at \$721 million. Though highly erratic, real, total fire management expenditures from FY 1970-98 show a statistically significant ($p = 0.01$) compound growth rate of 2.1 percent annually, about one-third the rate of nominal expenditures. Even with FY 1994 removed from the time series of real, total expenditures, the trend remains statistically significant ($p = 0.01$), but the compound growth rate drops to 1.8 percent annually. On the basis of constant 1998 dollars, about \$14.3 billion were spent on fire management activities for FY 1970-98, an amount 49.0 percent greater than when measured in current-year dollars.

Fire management expenditures are generally divided into two broad categories: Forest Fire Preparedness and Fire Operations. The specific activities accomplished under each category are referred to as "work activities." For example, PF1142 is the activity code used for work related to fire detection. We grouped work activities into aggregates, mainly because there are too many to meaningfully assess individually. Presuppression includes expenditures for preventing, detecting, dispatching, planning, training, overhead, and staffing the initial attack organization. The initial attack organization includes recruiting, hiring, training, personnel compensation, equipment, and other such resources. Fuels improvement refers to action taken to reduce fire hazard, such as through prescribed burning. Suppression expenditures refer to those incurred after a natural fire has been declared a "wildfire" or when Presuppression funding is inadequate to cover all initial attack expenses. Emergency fire Rehabilitation expenditures prevent additional damage resulting from suppression actions by performing activities such as repairing trails and fences, water baring fire lines, and repairing drainage ditches. Severity expenditures are for emergency presuppression actions needed because of higher-than-average fire danger and potential fire severity. Economic efficiency expenditures are used to provide non-emergency presuppression capability, resulting from an imbalance between Preparedness and Operations appropriations. Reimbursable Expenses are only temporary expenses, because they represent amounts that other organizations (e.g., state agencies) pay the Forest Service for services rendered (Reimbursable Expenses are shown for information only and are not included in totals). The Other categories consist of work activities that did not clearly fit other categories, such as law enforcement.

Overall expenditures (nominal dollars) for the Fire Preparedness and Fire Operations fund codes, and the aggregates of work activities within each, were determined (*table 2*). Expenditures in constant 1998 dollars were also determined and should be used to identify changes in "real" fire management expenditures (*table 3*). Expenditures not shown (i.e., "---") represent situations where the work activity aggregate was not functional. For example, Severity begins in FY 1987; it did not exist in prior years. Similarly, appropriations for Fuels did not begin until FY 1977 and in FY 1998 fuel treatments were funded under the fire Operations fund code, instead of Preparedness.

The historical level of nominal expenditures in both categories were determined (*fig. 3*). Because Severity expenditures in FY 1987-98 and Economic Efficiency expenditures in FY 1993-95 were intended to supplement Presuppression expenditures, they were added to Fire Preparedness totals and subtracted from the Fire Operations totals. Several features stand out. First, the expenditures appear somewhat equivalent in magnitude, although (adjusted) Fire Operations expenditures are far more erratic. Indeed, over the FY 1970-98 period, annual Fire Operations expenditures averaged about \$169.0 million, only 4.9 percent greater than those for Fire Preparedness, which averaged \$161.1 million annually. However, the variability of Fire Operations expenditures (measured by the standard deviation) was 64.9 percent greater than those for Fire Preparedness. Second, although Fire Operations expenditures accounted for 51.2 percent of the overall total, the mix has been changing. In the early years, Fire Fire Preparedness

Fire Management Expenditures---Schuster

Table 2--Forest Service wildland fire management expenditures, FY 1970-98, for Fire Preparedness and Fire Operations, by major class of expenditure.

Fiscal year	Fire Preparedness					Fire Operations							Grand total	
	Presuppression	Fuels	Other	Reimbursement	Total	Suppression	Fuels	Rehabilitation	Severity	Economic Efficiency	Other	Reimbursement		Total
1970	\$28,234,106	----	\$63,470	\$4,382,432	\$28,297,576	\$27,425,705	----	----	----	----	\$3,123	\$1,044,519	\$27,428,828	\$55,726,404
1971	30,139,322	----	62,278	4,410,889	30,201,600	82,929,089	----	----	----	----	0	2,388,901	82,929,089	113,130,688
1972	30,194,836	----	130,533	3,469,939	30,325,369	60,508,114	----	----	----	----	0	3,011,878	60,508,114	90,833,483
1973	31,618,290	----	0	3,531,627	31,618,290	62,141,570	----	----	----	----	0	2,039,041	62,141,570	93,759,860
1974	35,864,090	----	0	3,920,551	35,864,090	110,053,738	----	----	----	----	4,740	5,299,819	110,058,478	145,922,569
1975	47,020,132	----	2,923,219	4,114,908	49,943,351	114,479,335	----	----	----	----	16,305	4,311,228	114,495,641	164,438,992
1976	38,354,111	----	0	7,607,043	38,354,111	150,803,587	----	----	----	----	17,619	2,829,235	150,821,206	189,175,316
76TQ	13,781,468	----	782,350	1,610,810	14,563,818	70,200,929	----	----	----	----	8,457	1,628,897	70,209,386	84,773,204
1977	111,254,555	\$5,368,327	26,400,244	1,238,337	143,023,126	95,435,588	----	\$695,522	----	----	13,218	7,140,402	96,144,328	239,167,454
1978	104,541,207	11,528,545	26,968,773	983,107	143,038,524	27,683,921	----	630,858	----	----	127,900	2,630,034	28,442,679	171,481,203
1979	115,288,501	14,666,134	1,028,759	863,706	130,983,394	80,339,053	----	315,594	----	----	366,960	4,509,465	81,021,606	212,005,000
1980	138,338,458	21,088,634	113,287	1,588,200	159,540,378	63,375,264	----	1,365,721	----	----	4,242	4,444,461	64,745,227	224,285,605
1981	151,709,352	19,549,933	81,089	1,625,186	171,340,374	97,822,618	----	1,233,216	----	----	2,673	7,094,653	99,058,508	270,398,881
1982	124,894,897	16,297,431	45,486	1,652,115	141,237,814	27,158,985	----	102,785	----	----	407	2,563,519	27,262,178	168,499,992
1983	135,081,899	17,833,106	28,003	1,814,343	152,943,008	31,803,617	----	126,220	----	----	244	3,370,927	31,930,081	184,873,088
1984	139,024,025	17,180,623	23,254	1,585,927	156,227,902	62,011,053	----	215,743	----	----	514	4,036,845	62,227,310	218,455,212
1985	141,477,807	15,030,631	9,412	1,799,915	156,517,850	160,473,143	----	1,018,252	----	----	11,721	5,197,209	161,503,116	318,020,966
1986	140,804,355	8,545,330	21,647	1,625,160	149,371,331	110,252,540	----	1,371,391	----	----	1,405	3,725,007	111,625,335	260,996,666
1987	145,674,975	9,499,856	17,343	1,619,727	155,192,175	252,402,013	----	622,714	\$631,523	----	1,403	7,162,062	253,657,652	408,849,827
1988	150,798,495	6,685,323	4,965,681	1,438,410	162,449,499	413,603,415	----	5,021,616	10,995,389	----	-10,678	12,948,665	429,609,741	592,059,240
1989	144,755,945	6,522,766	7,793,121	23,011	159,071,832	317,762,959	----	6,628,811	7,280,089	----	980	7,932,637	331,672,839	490,744,671
1990	158,824,765	7,887,609	9,617,165	490,492	176,329,539	219,750,976	----	2,409,328	27,341,672	----	0	4,145,530	249,501,976	425,831,515
1991	162,674,056	7,835,434	10,213,793	1,195,858	180,723,283	109,938,530	----	1,072,363	23,408,707	----	12,188	1,317,995	134,431,789	315,155,071
1992	169,620,330	7,451,460	10,692,499	760,533	187,764,290	254,825,229	----	1,903,222	29,160,879	----	13,910	4,933,584	285,903,239	473,667,529
1993	164,620,006	12,362,925	9,902,220	2,079,214	186,885,150	108,512,905	----	7,524,319	3,400,296	\$58,713,436	13,821	1,931,675	178,164,777	365,049,927
1994	141,293,264	11,465,698	33,614,071	2,202,217	186,373,033	667,557,238	----	9,505,075	6,225,922	71,624,391	3,007,902	4,605,170	757,920,528	944,293,562
1995	105,486,062	16,643,994	37,175,091	2,654,180	159,305,147	167,660,724	----	12,768,948	4,778,848	125,058,587	4,154,677	8,209,433	314,421,785	473,726,931
1996	219,978,489	19,407,893	46,870,427	1,649,433	286,256,809	493,420,582	----	5,505,429	16,304,408	----	2,561,468	7,032,980	517,791,886	804,048,695
1997	238,639,552	28,164,150	56,156,301	3,186,159	322,960,003	151,326,227	----	5,477,215	4,549,525	----	4,432,969	12,274,056	165,785,936	488,745,939
1998	247,458,613	----	65,410,239	3,421,353	312,868,852	219,051,395	\$39,807,275	1,370,710	3,887,661	----	8,998,660	65,160,226	273,115,701	585,984,552

Table 3- Forest Service wildland fire management expenditures, FY 1970-98, in 1998 dollars, for Fire Preparedness and Fire Operations, by major class of expenditure.

Fiscal year	Fire Preparedness					Fire Operations								Grand total
	Presuppression	Fuels	Other	Reimbursement	Total	Suppression	Fuels	Rehabilitation	Severity	Economic Efficiency	Other	Reimbursement	Total	
1970	\$108,370,668	----	\$243,617	\$16,821,043	\$108,614,286	\$105,267,790	----	----	----	----	\$11,987	\$4,009,165	\$105,279,777	213,894,063
1971	110,022,412	----	227,343	16,101,776	110,249,754	302,729,384	----	----	----	----	0	8,720,590	302,729,384	412,979,138
1972	105,210,273	----	454,828	12,090,583	105,665,101	210,833,248	----	----	----	----	0	10,494,526	210,833,248	316,498,349
1973	105,529,028	----	0	11,787,138	105,529,028	207,403,358	----	----	----	----	0	6,805,491	207,403,358	312,932,385
1974	111,624,673	----	0	12,202,462	111,624,673	342,535,179	----	----	----	----	14,753	16,495,347	342,549,933	454,174,606
1975	132,686,630	----	8,249,065	11,611,904	140,935,695	323,050,505	----	----	----	----	46,012	12,165,901	323,096,517	464,032,212
1976	100,942,045	----	0	20,020,553	100,942,045	396,891,547	----	----	----	----	46,370	7,446,106	396,937,917	497,879,962
76TQ	36,270,678	----	2,059,023	4,239,400	38,329,700	184,757,909	----	----	----	----	22,258	4,287,004	184,780,166	223,109,867
1977	272,108,223	\$13,129,943	64,570,152	3,028,746	349,808,318	233,417,933	----	\$1,701,119	----	----	32,330	17,464,114	235,151,382	584,959,700
1978	238,856,281	26,340,477	61,618,390	2,246,208	326,815,148	63,252,364	----	1,441,387	----	----	292,226	6,009,115	64,985,977	391,801,125
1979	243,283,303	30,948,668	2,170,900	1,822,604	276,402,871	169,532,520	----	665,971	----	----	774,363	9,515,933	170,972,854	447,375,725
1980	268,089,103	40,868,121	219,540	3,077,807	309,176,764	122,816,302	----	2,646,661	----	----	8,220	8,613,018	125,471,183	434,647,947
1981	267,634,680	34,488,580	143,051	2,867,035	302,266,310	172,571,597	----	2,175,551	----	----	4,716	12,515,874	174,751,864	477,018,174
1982	205,793,542	26,853,828	74,949	2,722,246	232,722,319	44,750,778	----	169,363	----	----	671	4,223,997	44,920,812	277,643,130
1983	212,753,066	28,087,019	44,104	2,857,577	240,884,189	50,090,479	----	198,796	----	----	384	5,309,187	50,289,658	291,173,847
1984	210,811,509	26,052,138	35,262	2,404,849	236,898,910	94,031,544	----	327,145	----	----	779	6,121,341	94,359,468	331,258,378
1985	207,387,654	22,032,907	13,796	2,638,436	229,434,358	235,232,291	----	1,492,622	----	----	17,181	7,618,417	236,742,094	466,176,452
1986	200,689,879	12,179,746	30,853	2,316,357	212,900,478	157,144,066	----	1,954,658	----	----	2,002	5,309,290	159,100,726	372,001,204
1987	201,798,398	13,159,815	24,025	2,243,750	214,982,239	349,643,593	----	862,623	\$874,827	----	1,944	9,921,351	351,382,987	566,365,226
1988	201,884,759	8,950,121	6,647,913	1,925,702	217,482,792	553,720,549	----	6,722,797	14,720,315	----	-14,296	17,335,306	575,149,366	792,632,158
1989	185,929,818	8,378,079	10,009,769	29,557	204,317,666	408,146,341	----	8,514,286	9,350,813	----	1,259	10,188,969	426,012,698	630,330,364
1990	195,875,351	9,727,628	11,860,654	604,914	217,463,633	271,014,408	----	2,971,375	33,719,928	----	0	5,112,598	307,705,712	525,169,345
1991	192,362,280	9,265,410	12,077,824	1,414,103	213,705,515	130,002,454	----	1,268,071	27,680,826	----	14,412	1,558,531	158,965,763	372,671,278
1992	194,859,835	8,560,238	12,283,543	873,700	215,703,616	292,743,223	----	2,186,421	33,500,018	----	15,980	5,667,701	328,445,641	544,149,258
1993	184,251,230	13,837,225	11,083,077	2,327,164	209,171,532	121,453,259	----	8,421,607	3,805,788	\$65,715,116	15,469	2,162,031	199,411,239	408,582,771
1994	154,411,816	12,530,246	36,735,012	2,406,685	203,677,075	729,537,439	----	10,387,586	6,803,975	78,274,448	3,287,175	5,032,743	828,290,623	031,967,698
1995	112,393,236	17,733,835	39,609,297	2,827,975	169,736,368	178,639,065	----	13,605,053	5,091,765	133,247,361	4,426,724	8,746,982	335,009,967	504,746,335
1996	229,091,912	20,211,936	48,812,208	1,717,767	298,116,057	513,862,356	----	5,733,512	16,979,878	----	2,667,586	7,324,347	539,243,331	837,359,388
1997	243,169,343	28,698,754	57,222,245	3,246,638	329,090,342	154,198,660	----	5,581,182	4,635,883	----	4,517,114	12,507,039	168,932,840	498,023,181
1998	247,458,613	----	65,410,239	3,421,353	312,868,852	219,051,395	\$39,807,275	1,370,710	3,887,661	----	8,998,660	65,160,226	273,115,701	585,984,552

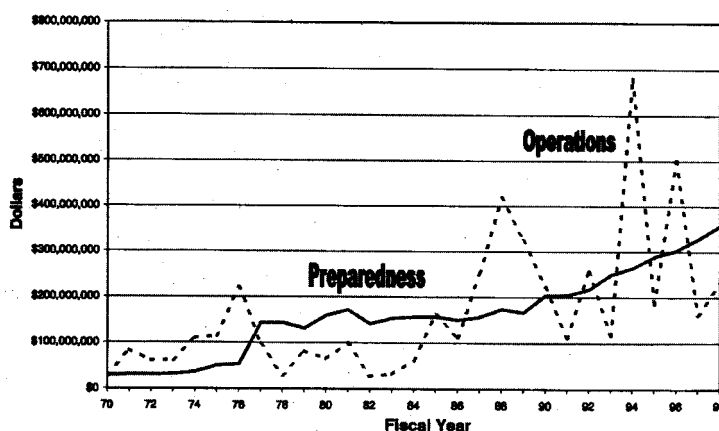


Figure 3
Fire preparedness and fire operations expenditures, FY 1970-98, by year. Preparedness includes Operations and excludes Economic Efficiency, Severity, and Fuels.

Operations expenditures accounted for 68.7 percent of the total, but only 53.3 percent in later years. Third, it is not clear on a yearly basis which category has the larger expenditure. In about half of the years (both recent and in the past), Fire Preparedness expenditures exceeded those for Fire Operations. Fourth, both Preparedness and Operations expenditures demonstrated statistically significant compound growth rates, 8.7 percent ($p = 0.00$) for Fire Preparedness expenditures and 6.6 percent ($p = 0.00$) for Fire Operations expenditures.

The increase in fire management expenditures (1998 dollars) was not uniform within fire activities or among regions (*table 4*). Overall, annual average expenditures increased by almost \$350 million per year, from the FY 1970-74 average of \$342 million to an average of \$691 million during FY 1994-98. Overall, expenditure changes in Fire Operations accounted for about 55.8 percent of all changes and expenditure changes in R-5 (California) and WO+ accounted for 25.7 percent and 20.9 percent of the changes, respectively. The largest, single area of change involved Fire Operations by the WO+, which accounted for 15.8 percent of the total change. WO+ expenditures include expenses of operating the WO-FAM staff, funding research (Missoula, Montana and Riverside, California) and development (Missoula, Montana and San Dimas, California) projects, operating the National Advances Resource and Technology Center (Marana, Arizona) for advanced fire management training, and supporting the Forest Service portion of the National Interagency Fire Center (Boise, Idaho) which provides national contracts for air tankers, helicopters, etc. Almost one-third of Preparedness increases was accounted for by expenditures in R-5, which also accounted for 14.0 percent of the total increase. Expenditure changes in R-9 (the Eastern) and R-10 (Alaska) accounted for the smallest portion of Fire Preparedness and Fire Operations changes.

Table 4-Total and percentage distribution of Fire Preparedness and Fire Operations expenditure changes, FY 1970-74 average relative to FY 1994-98 average, in 1998 dollars.

Forest Service region	Expenditure change			Percent distribution		
	Preparedness	Operations	Total	Preparedness	Operations	Total
R-1	\$12,292,697	\$11,894,431	\$24,187,127	0.04	0.03	0.07
R-2	6,831,555	7,783,118	14,614,673	0.02	0.02	0.04
R-3	19,313,650	9,421,801	28,735,451	0.06	0.03	0.08
R-4	14,672,599	22,375,734	37,048,333	0.04	0.06	0.11
R-5	48,997,988	40,929,272	89,927,260	0.14	0.12	0.26
R-6	25,125,159	14,325,897	39,451,056	0.07	0.04	0.11
R-8	8,062,686	23,093,658	31,156,344	0.02	0.07	0.09
R-9	754,330	6,514,414	7,268,743	0.00	0.02	0.02
R-10	551,525	3,515,647	4,067,171	0.00	0.01	0.01
WO+	17,758,982	55,305,381	73,064,363	0.05	0.16	0.21
Total	\$154,361,170	\$195,159,352	\$349,520,523	0.44	0.56	1.00

Fire Preparedness

Not only did nominal Fire Preparedness (including Severity and Economic Efficiency) expenditures rise dramatically during the study period, those expenditures also increased when expressed in 1998 dollars (*fig. 4*). In constant dollars, (adjusted) Fire Preparedness expenditures rose at a statistically significant ($p = 0.00$) compound rate of 3.4 percent annually, about one-third the rate expressed in nominal dollars. In constant dollars, those Fire Preparedness expenditures accounted for 50.8 percent of all fire management expenditures in FY 1970, dropped to a minimum of 19.3 percent in FY 1976, rose to a maximum of 83.8 percent in FY 1982, and decreased to 60.8 percent in FY 1998.

Presuppression

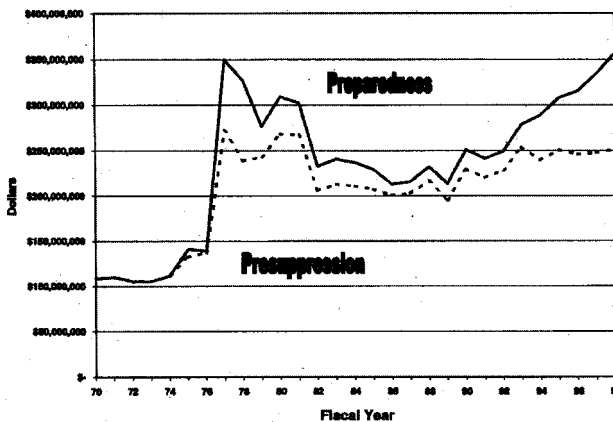
Expenditures for Presuppression have dominated Fire Preparedness expenditures (*fig. 4*). During the FY 1970-98 time period, Presuppression (including Severity and Economic Efficiency) accounted for 86.8 percent of all Preparedness expenditures, averaging about \$204 million (1998 dollars) over this period. In fact, these (adjusted) Presuppression expenditures rose at a statistically significant ($p = 0.00$) compound rate of 2.8 percent annually over the time period. However, the most notable aspect of Presuppression expenditures (and hence Fire Preparation expenditures) is the sharp rise in FY 1977. This rise reflected increased fire presuppression appropriations after the large fires of 1967, 1970, and 1972, and the 1972 fire re-planning effort, which recommended increased presuppression resources. In FY 1972, the "10:00 A.M." policy was replaced by "appropriate suppression response" for escaped fires. In FY 1978, this was extended to initial attack. Pre-attack planning probably caused expenditure increases. Considering the FY 1977-98 period only, neither Presuppression nor Fire Preparation expenditures displayed a statistically significant trend.

Though labeled "presuppression," some expenditures contained in Presuppression are actually for suppressing forest fires. For example, the work activity (PF12) covering fire suppression constituted 2.2 percent of the Presuppression expenditures for the period FY 1991-95. This situation results from fiscal and accounting conventions. Fire suppression activities are charged to Presuppression for the base salary (the first 8 hours) of Preparedness-funded, initial-attack personnel. Overtime, hazard pay, and any other expenses not included in the Preparedness budget are charged to Suppression in the Operations budget. Additionally, if backup personnel replace Preparedness-funded presuppression personnel at their home unit, backup personnel expenses are charged to Presuppression and all personnel expenses for the original presuppression personnel are charged to Operations-Suppression.

Fuels Improvement

Expenditure information for Fuels Improvement begins in FY 1977 (*fig. 5*); but that does not mean that activities to improve fuels did not take place before FY 1977. Rather, before FY 1977 Timber Management staffs controlled all

Figure 4
Fire preparedness and presuppression expenditures, FY 1970-98, by year. Preparedness includes Economic Efficiency, Severity, and Fuels while Presuppression includes Economic Efficiency and Severity.



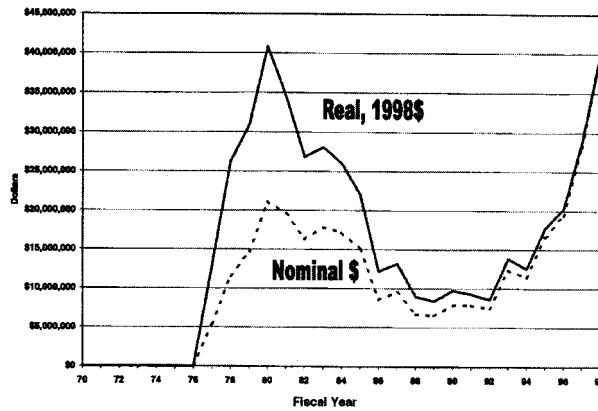


Figure 5
Fuel treatment expenditures, FY 1970-98, by year.

expenditures related to Fire Preparedness, not FAM staffs. Because Timber Management staffs also conduct fuels improvement activities not related to fire protection (e.g., slash reduction in timber sales), the accounting system could not distinguish between timber-related fuels improvement from fire management fuels improvement. Starting with the new Federal fiscal year configuration in FY 1977, Fire Preparedness appropriations came under the control of FAM.

Expenditures on fuel treatments have been extremely variable over the period FY 1977-98. They rose sharply during the decade of the 1970's (*fig. 5*). In fact when expressed in constant 1998 dollars, expenditures reach a peak in FY 1980 of \$40.9 million, exceeding those of \$39.8 million in FY 1998. Fuel treatment expenditures steadily decreased during the decade of the 1980's, reaching a low of about \$9 million (1998 dollars) at the end of the decade. Fuel treatment expenditures generally increased during the decade of the 1990's. Nevertheless, average annual expenditures during the 1990's of \$17.8 million were still 19.4 percent below the annual average of \$22.1 million during the 1980's. As a result of this extreme variability, no statistical trend in fuel treatment expenditures can be detected over the period FY 1977-98, for either nominal or constant dollars. However, during the 1990's, annual expenditures on fuel treatments (1998 dollars) rose at a statistically significant ($p = 0.00$) compound rate of 20.1 percent annually.

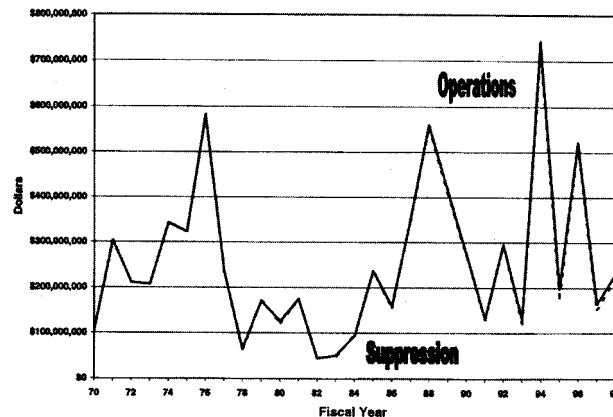
Fire Operations

Expenditures related to Fire Operations were far more difficult to evaluate at the level of work activity aggregates than were Fire Preparedness expenditures. The main reason for this is that only one aggregate, Suppression, existed over the entire FY 1970-98 time period. Rehabilitation was formally recognized in FY 1977; Severity began in FY 1987; Economic Efficiency began in FY 1993 and ended in FY 1995; and Fuels began in FY 1998. In the case of Rehabilitation, the appropriate work activity code did not exist before FY 1977; thus, any rehabilitation work was charged to another code. The work activity code used to measure Severity existed before FY 1987 but could not be used with Fire Operations appropriations. The work activity code used for Economic Efficiency existed in FY 1991 but was little used until FY 1993 when it was designated for use with Economic Efficiency.

As with nominal dollars, expenditures for Fire Operations (excluding Severity, Economic Efficiency, and Fuels) measured in constant 1998 dollars have been extremely erratic from FY 1970-98 (*fig. 6*). The same is true for Suppression expenditures. Indeed, because Suppression expenditures accounted for 98.6 percent of (adjusted) Fire Operations expenditures from FY 1970-98, the two expenditure series cannot be distinguished, and will be treated as one series (*fig. 6*). *Figure 3* displayed annual (adjusted) Fire Operations expenditures measured in nominal dollars and a statistically significant compound growth rate of 6.6 percent annually. A completely different picture is portrayed in constant 1998 dollars. In constant dollars, (adjusted) Fire Operations expenditures averaged \$254.5 million during the 1970's, dropped to \$221.3 million during the

Figure 6

Fire operations and suppression expenditures, FY 1970-98, by year. Operations exclude Economic Efficiency, Severity, and Fuels.



1980's, and increased to \$298.4 million during the 1990's. The intervening years were highly volatile, with the most expenditures in FY 1994 (\$743 million) exceeding the least expenditures in FY 1982 (\$45 million) by a factor of sixteen. Not surprisingly, when those annual Fire Operations expenditures are measured in constant 1998 dollars, no statistically significant ($p = 0.38$) trend can be discerned. However, the variability in annual Fire Operations expenditures is increasing. If variability in expenditures (as portrayed by the standard deviation) is indexed at 100 for the 1970's, the 1980's index would be 117, meaning that annual Operations expenditures were about 17 percent more variable during the 1980's than during the 1970's. The 1990's index would be 141, meaning that Operations expenditures during the 1990's were about 41 percent more variable than during the 1970's.

Discussion

There is little doubt that over the period FY 1970-98 the annual number of fires has been decreasing, but at the same time, the number of acres burned and overall fire management expenditures have been increasing. Over that time period, nominal expenditures increased at an annual compound rate of 7.4 percent and real expenditures increased by about 2.1 percent annually. The bulk of expenditure increase was in Fire Operations (formerly called Fighting Forest Fires), which consists mainly of fire suppression expenditures. Although nominal Fire Operations expenditures showed a positive statistical trend, no trend was discernible when annual expenditures were expressed in constant 1998 dollars. However, as might be suspected, Fire Operations expenditures are becoming increasingly variable over time. Expenditures on Fire Preparedness (formerly called Fire Protection) have displayed a positive statistical trend, whether measured in nominal or constant 1998 dollars. Although expenditures on fuel treatments have been increasing recently, they have been so variable over time that no statistical trend could be identified over the FY 1970-98 period. However, expenditures on fuels have risen remarkably during the 1990's.

Expenditure data on fire management are at the same time satisfying and frustrating. We have now developed an extensive time series of detailed fire management expenditure information. The biggest difficulties involved the early years. Many records were unavailable and information had to be developed from a variety of sources. Future data on fire management expenditures should be easily obtained because of modern, electronic accounting systems. However, accounting systems evolve to meet the needs of fire management and financial management. Over time, one challenge will be to maintain enough detailed information so that trends in data series can be evaluated, despite changes in accounting specifics. Another frustration with accounting and budgeting systems is the mixing and movement of work activity aggregates between fund codes.

This can be confusing. For example, Congress appropriates monies for Fire Operations, which is a perfectly legitimate accounting level (*tables 2, 3*). However, in FY 1998 appropriations for Fire Operations included appropriations for fuel treatments, which were previously contained in appropriations for Fire Preparedness. The other frustration results from major changes in the accounting system, such as those currently taking place as the Forest Service attempts to implement the new Federal Financial Information System (FFIS). Effective with FY 2000, FFIS promises to provide more accurate and timely financial information. Hopefully, any problems with the accounting system will be short-lived and allow sustained measurement and monitoring of fire management expenditures.

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