

# Forest Service Fire Suppression Expenditures in the Southwest<sup>1</sup>

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## Abstract

Fires in the Southwest (SW) are notorious and prominently featured in the national media, including the evening news—Storm King, Los Alamos, and the 2002 fires of Colorado and Arizona. The cost of suppressing these fires is staggering and continues to grow. Consequently, suppression costs for fires in the SW are one of the primary forces behind the National Fire Plan with its emphasis on fuel treatments and suppression cost reduction. In this paper, we inspect Forest Service (FS) fires in the SW and contrast them with fires in a larger geographical context—the U.S. and the rest of the West. We inspect characteristics of SW fires, such as their size and fuel types, and how these characteristics affect suppression costs. Cost contrasts focus on several key aspects of fire suppression, including predicting fire-specific suppression costs (making reference to regression analysis), differences in the make-up of suppression costs (e.g., personnel versus equipment), where firefighting resources come from (SW as a sink or source), and agency cooperation (other federal and state).

## Introduction

The official title of this 2002 fire conference is “Managing Fire and Fuels in the Remaining Wildlands and Open Spaces of the Southwestern U.S.” The title seems innocent enough. Managing fire and fuels sounds like a perfectly neutral, professional undertaking, but there probably is substantial disagreement as to why one would pursue such a venture. Some might argue that management is needed to restore ecosystems to some pre-European settlement condition. Others might argue that management is needed to attain some less historically based state of nature. Those perspectives seem well-grounded in physical and biological sciences. They reflect the perspective that natural systems are out of balance and need to be fixed.

This paper takes the perspective that fire and fuels are to be managed because the current state of nature is intolerably expensive—because natural systems are out of balance. In fiscal year (FY) 2002, the Forest Service (FS) spent about \$1.3 billion in fire suppression. Expressed in constant 2001 dollars, annual expenditures for the past 30 yr averaged about \$250 million. In FY 2000 and again in FY 2002, we broke the billion-dollar mark, four times the annual average. The hard-nosed might argue that the entire reason for undertaking fire prevention and detection, improving initial attack, expanding fuel treatments, and restoring ecosystems is simply to lower fire suppression expenses.

If that is the case, what are the determinants of suppression expenses for FS fires in the southwestern U.S.; how do Southwest (SW) fires fit into the bigger FS picture; how have FS expenses changed over time; and how do FS expenses fit into the bigger, national picture? We address these questions in reverse order.

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## Federal Fire Suppression Expenditures

In the arena of Federal fire suppression on wildlands and open spaces, there is one agency from the U.S. Department of Agriculture (USDA) and four from the U.S. Department of the Interior (USDI). The FS is the sole USDA agency. USDI includes the Bureau of Land Management (BLM), Bureau of Indian Affairs (BIA), National Park Service (NPS), and Fish and Wildlife Service (FWS).

The best information on Federal fire suppression expenditures is the National Interagency Fire Center (NIFC) website (<http://www.nifc.gov/>). Among the five Federal agencies, the FS spends the most (*table 1*). Between 1994 and 2000, the FS incurred nearly three-fourths of the Federal expenses. Annual FS suppression costs ranged from about 60 to 80 percent of the total; BLM was second, incurring about 15 percent. Although agency expenditures vary annually, the order does not: FS and BLM are always first and second, with BIA, NPS, and FWS following in that order.

**Table 1**—Fire suppression expenditures in dollars by Federal agencies, FYs 1994 to 2000.

Year	Bureau of Land Management	Bureau of Indian Affairs	Fish and Wildlife Service	National Park Service	USDA Forest Service	Totals
1994	98,417,000	49,202,000	3,281,000	16,362,000	678,000,000	845,262,000
1995	56,600,000	36,219,000	1,675,000	21,256,000	224,300,000	340,050,000
1996	96,854,000	40,779,000	2,600	19,832,000	521,700,000	679,167,600
1997	62,470,000	30,916,000	2,000	6,844,000	155,768,000	256,000,000
1998	63,177,000	27,366,000	3,800,000	19,183,000	215,000,000	328,526,000
1999	85,724,000	42,183,000	4,500,000	30,061,000	361,000,000	523,468,000
2000	180,567,000	93,042,000	9,417,000	53,341,000	1,026,000,000	1,362,367,000

Federal agencies are not the only forces fighting fire. Most western states have firefighting organizations that coordinate local units. Although comprehensive data are not available on the role of FS suppression activity in this larger context, we developed some relevant data from our research. We identified total suppression expenditures for large fires fought by the FS in the west during 1996 to 1997. The FS incurred 87 percent of costs, State and county forces incurred similar suppression expenses (7 percent) to other Federal agencies (6 percent).

### Forest Service Expenditures Over Time

FS fire suppression expenditures are increasing and becoming more erratic. Suppression expenditures can be expressed as actual values in the year they occurred and as inflation-adjusted. Time series data of actual suppression costs for FY 1970 to 2001 show increases in expenditures and variability (*fig. 1*). Analyses indicate a statistically significant ( $P < 0.01$ ) compound growth rate of expenditures averaging 7.7 percent per year. In FY 1988, the year of the Yellowstone National Park fires, expenditures averaged less than \$90 million annually; afterwards they averaged \$370 million. Moreover, expenditure variability also increased. The standard deviation of the mean cost increased 350 percent, from pre- to post-1988. Similarly, the standard deviation as a percentage of the mean, increased (from 63 to 70 percent).

Fire suppression expenditures can be expressed in constant dollars, reflecting an adjustment for inflation. *Figure 2* displays suppression expenditures expressed in FY 2001 dollars. When a time series of dollar values are expressed in terms of latter-year constant dollars, the constant dollar year acts as a fulcrum and early-year values are increased, thus flattening the time series. The compound growth rate, though still

statistically significant ( $P=0.03$ ), decreased to 3.1 percent per year. The breakpoint at FY 1988 is still present, but much less apparent. Prior to FY 1988, constant-dollar expenditures averaged \$200 million annually. From FY 1988 on, constant-dollar expenditures averaged more than \$400 million annually, a two-fold increase. However, based on constant dollars, relative variability increased. Although the standard deviation of the mean expenditure increased about 140 percent, from pre- to post-1988, the mean expenditure increased by only 105 percent. That means the standard deviation as a percentage of the mean increased by 17 percent, from 55 percent (pre-1988) to 64 percent (post-1988).

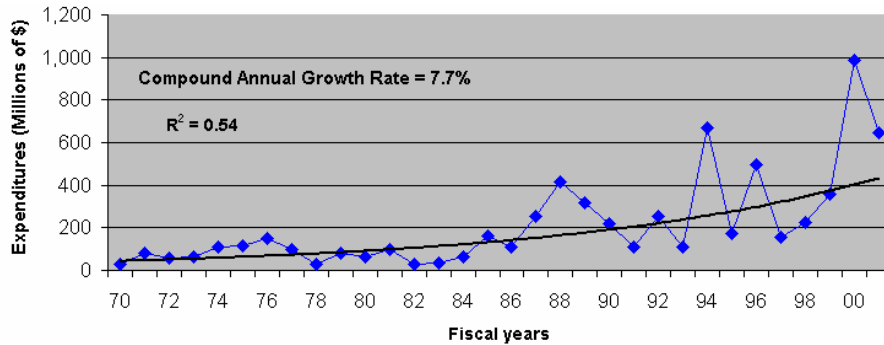


Figure 1—Forest Service fire suppression expenditures, FYs 1970 to 2001.

The role of key years in these analyses is critical. In particular FYs 1988, 1994, and 2000 are very influential. Continuing with constant-dollar analyses, but with the key years removed, the annual compound growth rate drops below 2 percent and is not statistically significant ( $P=0.21$ ). However, those years did occur. As a result, we can attest to an annual, compound growth rate of more than 3 percent, along with increased volatility.

### Forest Service Fires and the Southwest

With FS fire suppression costs dominating total suppression expenditures and with costs on the rise and becoming increasingly erratic, we turn to the role played by the SW. Data to address this question derive from the National Interagency Fire Management Integrated Database (NIFMID). The role played by SW fires depends on the focus, be it number of fires, acres burned, or suppression expenditures.

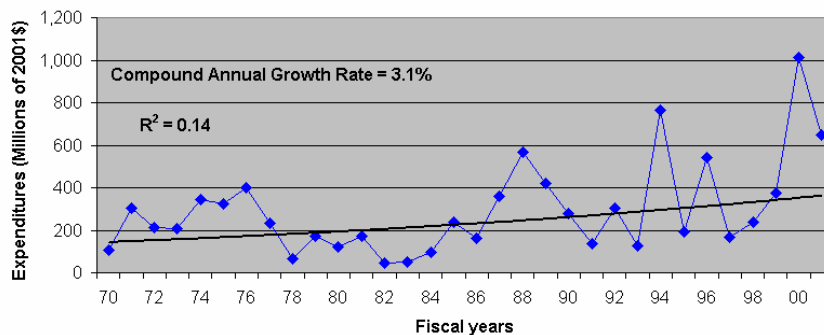
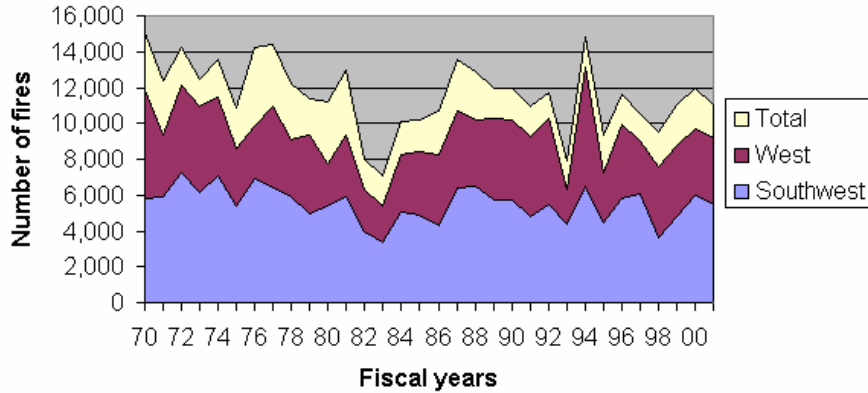


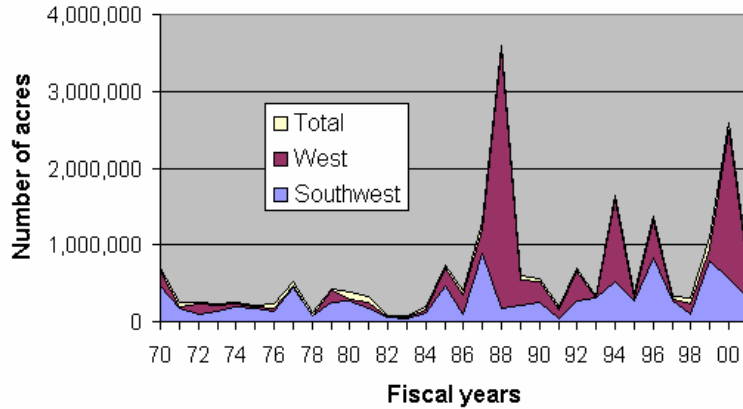
Figure 2—Forest Service fire suppression expenditures; 2001 dollars, FYs 1970 to 2001.

Over the past 3 decades, the FS has been involved with suppressing more than 370,000 fires, averaging more than 11,000 fires annually. The most fires occurred in 1970 and 1994 (*fig. 3*). Over those 3 decades, fires in the western US (FS Regions 1 to 6) dominate, accounting for about 80 percent of all FS fires. Within the west, the SW accounts for 60 percent of the fires: nearly half of fires nation-wide. The SW averages 5,500 fires annually, ranging from 3,400 (1983) to 7,300 (1972).



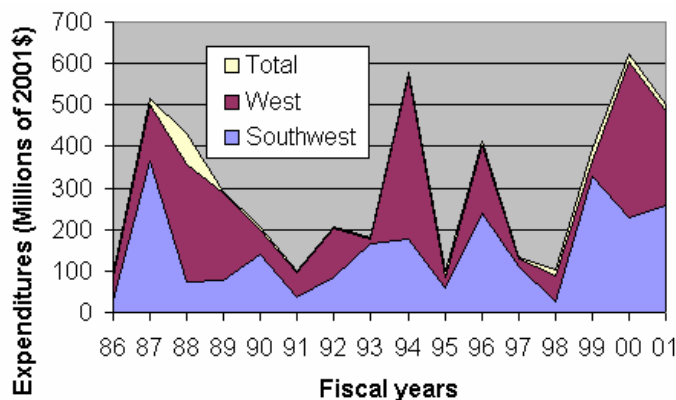
**Figure 3**—Number of Forest Service fires, FYs 1970 to 2001.

Nationally, fires with FS involvement, burned more than 21 million acres over the past 3 decades, averaging 660,000 ac annually. The most acres burned in 1988 (Yellowstone NP fire) and 2000 (Bitterroot NF fires), with 3.6 and 2.6 million ac respectively (*fig. 4*). Fires in the western U.S. accounted for 92 percent of all acres burned. Because the west dominates acres burned nationally, the temporal pattern in the west mirrors the overall national pattern. Such is not the case for the SW. Acres burned in the SW peaked in 1987 at 890,000 ac and dropped to 180,000 ac during 1988. Whereas the SW accounts for 60 percent of the western fires, it only accounts for 47 percent of the acres burned in the west. Over the past 30 yr, the SW accounted for 43 percent of acres burned nation-wide.



**Figure 4**—Forest Service acres burned, FYs 1970 to 2001.

NIFMID, the official FS records on fire-related activity, is not a perfect record. Information on estimated fire suppression costs lack credibility prior to 1986. However, cost estimates afterwards are adequate for comparisons. NIFMID-based information for FY 1986 to 2001 indicates FS annual suppression costs averaged \$356 million (*fig. 5*), whereas the financial system indicates \$388 million. Expenditures were highest in 2000 and lowest in 1986, both nationwide and for the west. The \$339 million average annual suppression costs in the west were 95 percent of the national total. Fire suppression costs in the SW roughly approximate the temporal pattern of the entire west. Costs averaged \$174 million, 53 percent of the west’s total, with most (\$729 million) in 1987 and least (\$109 million) in 1998. With information on fire number, acres burned, and suppression costs, we can assess differences in suppression cost per fire and acre burned. Nationwide, fires cost more than \$31,000 (2001\$) to suppress. The SW averaged \$33,000 per fire, while the rest of the west averaged \$40,000 (differences are not statistically significant:  $P=0.49$ ). However, the non-west average, \$8,000 per fire, is a statistically significant difference from western values ( $<0.01$ ). We analyzed the annual trend in SW cost per fire (2001\$) and found no statistically significant trend ( $P=0.52$ ).



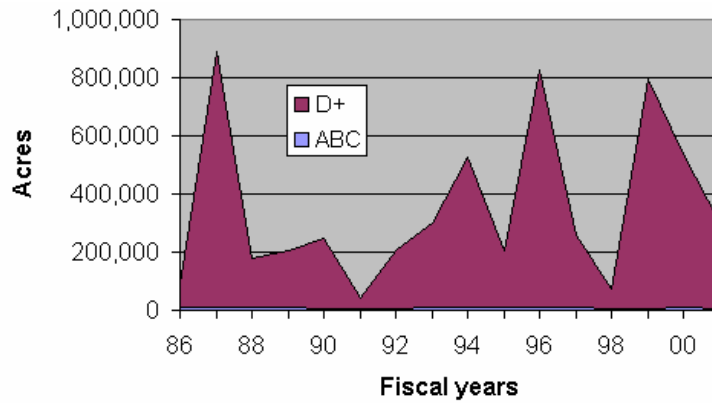
**Figure 5**—Forest Service fire suppression expenditures, FYs 1986 to 2001.

Nationwide, annual suppression cost per acre averaged \$430  $ac^{-1}$  (2001\$), but there are marked geographical differences. The SW averaged \$510  $ac^{-1}$  and the remainder of the west averaged about \$552  $ac^{-1}$ , a nonsignificant difference ( $P=0.71$ ). The non-west portion averaged \$266  $ac^{-1}$ , a statistically significant difference from the western values ( $P=0.03$ ). An analysis of annual cost per acre from 1985 to 2001 failed to reveal a significant trend ( $P=0.52$ ).

### **SW Fires—Large and Small**

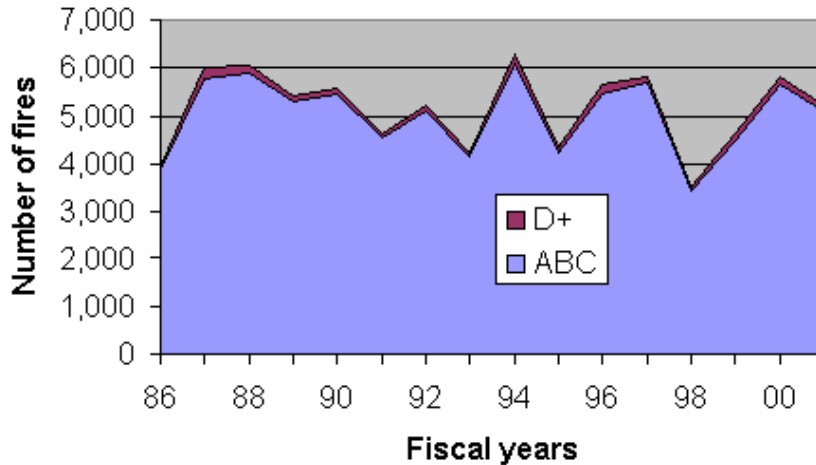
To better understand the differences between small (classes A, B, and C fires of < 100 acres) and large fires (class D and better fires, >100 ac), we focus on the number of fires, acres burned, and suppression costs. Because needed data derive from NIFMID, fires must be restricted to FYs 1986-2001. Since FY 1986, the FS has participated in fire suppression on more than 82,000 fires in the SW. Most occurred in FY 1994 (6,300 fires) and the least occurred in FY 1998 (3,500 fires) (*fig. 6*). Averaging about 5,100 fires annually, most were small. ABC fires constituted almost 80 percent of fires, averaging over 5,000 annually. That means there were only about

100 class D+ fires annually, spread over the six SW states. The portion represented by large, D+ fires is barely discernable (*fig. 6*).



**Figure 6**—Number of Forest Service fires in the Southwest, FYs 1986-2001.

D+ fires dominate acres burned, and ABC fires dominate the number of fires. About 355,000 ac burn annually in the SW. The most acres burned in FY 1987 (almost 890,000 ac), followed by FYs 1996 and 1999 when about 800,000 ac burned (*fig. 7*). Between FY 1986 and 2001, D+ fires burned an average of 346,000 ac annually, and accounted for 98 percent of acres burned. In *figure 7*, the portion of acres burned represented by the smaller, ABC fires is barely discernable.

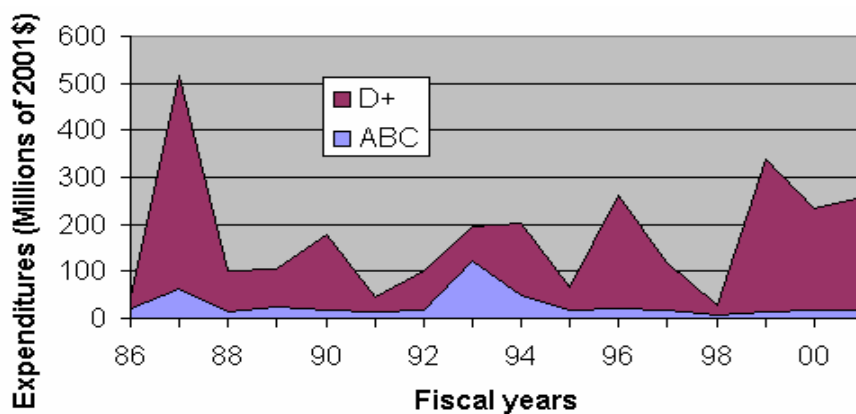


**Figure 7**—Forest Service acres burned in the Southwest, FYs 1986 to 2001.

Over the period FY 1986 to 2001, suppression expenditures in the SW averaged \$175 million annually (2001\$). FY 1987 was the most (\$518 million) (*fig. 8*), and FY 1998 was lowest (\$27 million), D+ fires accounted for the bulk of suppression expenditures at 84 percent while ABC fires comprised 16 percent.

## SW Expenditures—Prediction

To better understand suppression expenditures for individual, large fires, we conducted a series of statistical analyses to identify and evaluate major causal factors. We used multiple linear regression, where the dependent variable was total suppression expenditures (2001\$) and the independent variables were several dozen, fire-specific variables, such as acres burned and fuel type. Suppression expenditure information for each fire was obtained from FS accounting systems (Central Accounting Data Inquiry—CADI (for years prior to FY 2000) and Foundation Financial Information System—FFIS (for FY 2000 and beyond)). Fire-specific information was obtained from the NIFMID database and geospatial queries made of the 2000 Census of Population. We evaluated 485 D+ fires from the SW occurring from FY 1995 on, for which accounting and fire-specific information was available.



**Figure 8**—Forest Service fire suppression expenditures in the Southwest, 2001\$, FYs 1986 to 2001.

We used simple correlation coefficients to eliminate variables. For inclusion in the regression, the correlation between suppression expenditures and the variable had to be significant at  $P < 0.10$ . This eliminated two categories of variables. First, none of the initial suppression strategies (confine, contain, and control) were significantly correlated with suppression expenditures. Second, we used two types of measures to represent the wildland-urban interface: 1) distances to population centers of various sizes and 2) the amount of population within various distances of the fire. Population size was never significant while the distance to population was.

We built a multiple linear regression model from 16 candidate independent variables. Using stepwise and other model building techniques, we developed a model containing seven variables significant at the  $P = 0.15$  level (*table 2*). This model had an adjusted  $R^2 = 0.44$ , and standardized coefficients (depicting relative importance). First, with a standardized coefficient of 0.527, Acres Burned is more than twice as important as Net Value Change in influencing suppression expenditures. Second, the significance of Net Value Change means that suppression costs increase with more valuable lands. Third, suppression expenditures on timber/slash fires are significantly greater than grass/shrub fires. Fourth, other things equal, suppression expenditures on California fires are significantly higher than other SW states. Finally, there is evidence that proximity to a small town increases suppression costs.

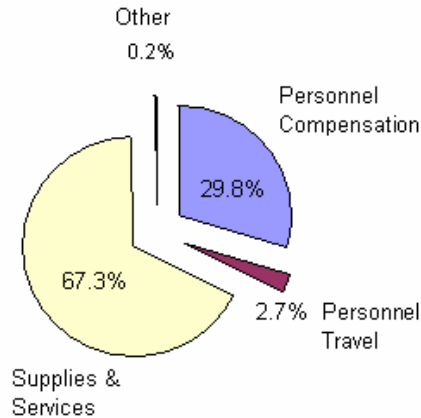
**Table 2**—OLS estimates of fire suppression expenditure model for large (D+) Forest Service fires in the SW: dependent variable = total per-fire suppression expenditures.

Variable	Std. coef.	P-Level
Acres burned	0.527	0.00
Net value change	0.182	0.00
Slope	0.148	0.00
Fuel type	0.140	0.00
California	0.111	0.01
Distance to place; 2,499 people	-0.063	0.11
Fire intensity level 6	0.055	0.15

**SW Expenditures—Detailed**

Questions arise as to what things are purchased through fire suppression expenditures. In accounting circles, “things” are “objects,” as outlined through “budget object codes.” As expenditures are entered into the accounting system, each type is recorded according to a hierarchical coding system. The Federal coding system has two problems. First, the system is not static over time, thus limiting our ability to accomplish detailed comparisons between years. Second, coding policies and procedures change over time, resulting in less detailed coding from year to year. Both problems frustrate detailed analyses, thus compelling more generalized evaluations. We accessed the Forest Service’s accounting system (Central Accounting Data Inquiry—CADI (prior to FY 2000) and Foundation Financial Information System—FFIS (FY 2000 and beyond)) records toward understanding SW suppression expenditures and how they differed from the rest of the west and nation in general.

The bulk of fire suppression expenditures are made for supplies and services (*fig. 9*). For large, D+ fires occurring from FY 1995 to 2001, supplies and services constituted nearly two-thirds of all suppression expenditures. This includes aviation, rent and utilities, printing, equipment, and various services. Personnel compensation accounts for about 30 percent of suppression expenditures. This category includes compensation and benefits of current employees and benefits to former personnel. The general pattern of expenditures does not differ in other geographical contexts. The percentage distribution of expenditures by category for the SW is almost identical for other western fires and, non-western fires nationwide.



**Figure 9**—Forest Service fire suppression expenditures by type in the Southwest, FYs 1995 to 2001.

## SW Expenditures—Financing

The final aspect of SW suppression expenditures deals with financing. Which FS fire-fighting organizations are responsible for suppressing large fires in the SW? To address this question, we used the NIFMID database to identify large SW fires and the FS accounting system database to identify cost patterns.

The SW area, consists of four FS regions: Pacific SW (PSW)-California, SW (SW) Arizona and New Mexico, Intermountain INT-Nevada and Utah, and Rocky Mountain (RM)-Colorado. *Table 3* shows SW suppression expenditures provided by FS regions and what each spent on large fires (e.g., firefighting expenditures from PSW accounted for 57 percent of SW fire suppression). Only about 20 percent came from the SW Region. The PSW expenditures accounted for 91 percent of its fire suppression expenditures; for the SW region, they accounted for 87 percent.

**Table 3**—Percentage of SW suppression expenditures provided by Forest Service regions and of each region's suppression expenditures spent on large SW fires.

Forest Service Region	Pct SW expenditures by Region	Pct Region expenditures in SW
Northern	1.41	6.65
Rocky Mountain	1.81	35.51
SWern	20.43	87.02
Intermountain	4.71	27.96
Pacific SW	56.57	90.96
Pacific Northwest	1.65	5.67
Southern	0.99	14.17
Eastern	0.65	29.81
Alaska	0.42	34.04
Washington Office	11.37	51.48

## Conclusions

The FS is the dominant player in Federal suppression expenditures. Over time, FS suppression expenditures are increasing in both level and variability, including constant dollar measures. Suppression expenditures in the SW account for half of FS suppression expenditures. Large fires constitute 2 percent of the FS fires in the SW, but 84 percent of suppression expenditures. Acres Burned is the most important variable affecting fire-specific suppression expenditures, followed by Net Value Change, Slope, and Fuel Type. Two-thirds of SW suppression expenditures go to supplies and services, the remainder to personnel. About three-fourths of FS suppression costs in the SW come from the Southwestern and PSW regions.

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