

**Forest Service Suppression Cost Forecasts and Simulation
Forecast for Fiscal Year 2010
Spring Update**

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Executive Summary

Fiscal year (FY) 2010 emergency suppression expenditures, including cost pool projections and national aviation contracts (estimated at \$355 million), are forecast to range, with 90 percent confidence, between \$920 million and \$1,525 million with a median forecast of \$1,222 million. The median is \$51 million lower than the forecast previously issued in November 2009. The lower forecast is the net result of: (1) lower forecasts for Forest Service Regions 2 and 3 because of alleviating drought conditions; (2) higher costs for Regions 5 and 6 because of persistent dry conditions in the Pacific Northwest and northern California; (3) substantially lower costs in Regions 8 and 9 because of a wetter than expected winter and spring; and (4) lower costs for the remainder of the Agency due to overall lower expected wildfire activity nationwide.

This forecast is based upon historical Forest Service fire suppression spending patterns from FYs 1995-2009. Therefore, it does not reflect any possible cost savings that might occur in FY 2010 due to changes in spending patterns brought about by management goals or operational efficiencies. Actual FY 2010 fire suppression expenditures may vary from the forecasted confidence interval.

Overview

Background

The high level of suppression expenditures since FY 2000 has led to budgetary complications for the Agency, often forcing spending reallocations within fiscal years. To give the Forest Service some advance warning (before the summer fire season ensues) of possible funding problems, researchers have developed models that can provide forecasts in the fall and the spring of the current fiscal year. This research is a collaborative effort of the Rocky Mountain Research Station (Krista Gebert) and the Southern Research Station (Jeffrey Prestemon and Karen Abt), funded by National Fire Plan research and Forest Service Fire and Aviation Management.

Modeling Framework for the 2010 Spring Current Year Model

This latest effort forecasts FY 2010 costs for regions or regional aggregates, using ocean temperature and atmospheric pressure indices and drought data available at the end of March of the current year. Suppression cost data are based on Forest Service accounting databases as compiled by the Forest Service Rocky Mountain Research Station. The dataset includes expenditures for the nine land management regions, as well as for the Rest of the Forest Service (RFS), which includes the National Offices, Research Stations, and the National Interagency Fire Center. Due to changes in the accounting of suppression expenditures at the regional level (starting in 2007), we had to make adjustments to our dataset in order to maintain consistency among years. This has resulted in a much shorter time series of consistent data upon which to build the forecasts. Previously, the forecast models were built using data from FY 1977 onward. The new dataset is significantly shorter, running from FY 1995 through FY 2009.

The forecast model is a set of statistical equations, each corresponding to individual regions or regional groupings. The use of the shorter (1995-2009) time series has necessitated some changes in the specification of the equations, both in terms of the variables used and the number of variables appearing in them. Additionally, we made changes to the regional groupings. Previously, an aggregate forecast was produced for Regions 1–6, with the remaining regions being modeled separately, for a total of five equations. This year we regrouped regions based upon recent cost correlations among regions, resulting in six cost forecast equations: (1) Region 1 and 4, (2) Region 2 and 3, (3) Region 5, (4) Region 6, (5) Region 8 and 9, and (6) Region 10 and the RFS. Region 10 was added to RFS because of the small amount of expenditures usually occurring in Region 10. The shorter time series of costs has led to fewer variables that could be included. With this greater parsimony has come somewhat reduced accuracy compared to previous models, which took advantage of over 30 years of suppression and explanatory variable data.

The six regional suppression cost equations are estimated simultaneously, and the equation interrelationships are captured in making agency-wide forecasts. Forecasts are made for each of the regional aggregates and the sum of these (i.e., for the agency as a whole). These individual cost equations are each specified slightly differently, but include some combination of broad scale climate indicators, such as the Southern Oscillation Index, the Niño-3 sea surface temperature anomaly, the Pacific Decadal Oscillation, the Atlantic Multidecadal Oscillation, and Palmer drought indices as well as a random error component. The result of the estimation is a set of parameter estimates (relating the independent variables to the suppression cost) and a random equation error distribution.

Monte Carlo simulation methods are applied to the estimated equations to understand the amount of uncertainty associated with the forecast for each regional aggregate and the agency as a whole. The Monte Carlo method involves adding random errors to each equation's parameter estimates and to each equation's residual error. The Monte Carlo method also captures the interrelationships among parameters of the cost models and the equation residual errors among regions. This method allows us to provide a median cost forecast for each cost equation (region or regional aggregate) and confidence intervals around the median cost. It also allows us to make inferences about the probability that the appropriated budget for emergency fire suppression will be sufficient to cover realized costs for the fiscal year.

FY 2010 Results (Spring update)

Fiscal year 2010 emergency suppression expenditures for the Agency as a whole, including cost pool and aviation charges, are forecast to range, with 90 percent confidence, from \$920 million to \$1,525 million with a median forecast of \$1,222 million (Table 1 and Figure 1). The Agency-wide forecast is further broken out by region or regional aggregate in Table 1.

Expenditures have a 99 percent probability of exceeding \$796 million (including the \$355 million Cost Pool charges, or \$441 million excluding them) (Table 2). They have a 1 percent probability of exceeding \$1,651 million (including the Cost Pool; \$1,296 excluding them).

After factoring out dollar inflation, these forecast costs are anticipated to be in the middle tercile (third) of the suppression expenditures observed since 1995 (Table 3) and the upper tercile observed since 1977. Compared to the previous 15 years, forecast costs for two of the regions or regional aggregates are anticipated to be in the middle tercile of costs, and one is likely to fall in the upper tercile (Table 3).

Table 1. Fiscal Year 2010 Emergency Suppression Cost Forecasts, by Region, Current (FY 2010) Dollars (Cost Pool and Special Aviation Charges Included in RFS): Spring Update

	Region 1 & 4	Region 2 & 3	Region 5	Region 6	Region 8 & 9	Region 10 & RFS	Total
	FY 2010 \$ Million						
Median	87	56	441	150	15	473	1,222
95% Confidence Lower Bound	0	0	270	16	0	386	861
95% Confidence Upper Bound	273	159	612	287	61	558	1,581
90% Confidence Lower Bound	0	0	297	37	0	400	920
90% Confidence Upper Bound	243	142	584	264	54	544	1,525

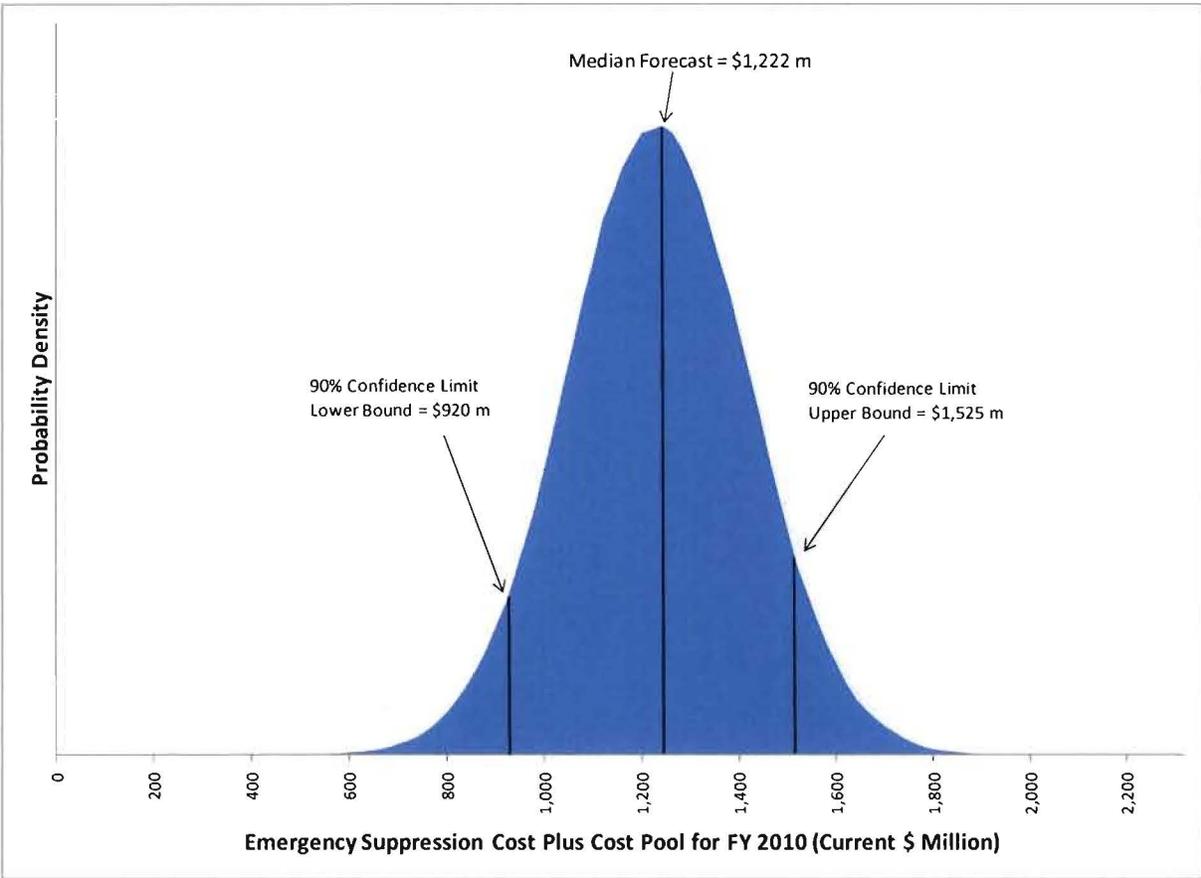


Figure 1. Fiscal Year 2010 emergency suppression expenditure forecast probability distribution (Spring Update).

Probability (%) of Falling Below Indicated Dollar Amount	Realized Amount (\$ Million 2010)
1	796
5	920
10	988
20	1,068
30	1,126
40	1,175
50	1,222
60	1,268
70	1,319
80	1,378
90	1,457
95	1,525
99	1,651

Table 3. Fiscal Year 2010 Emergency Suppression Cost Forecasts, by Terciles (Excluding Cost Pool and Special Aviation Charges): Spring Update

Region or Aggregate	Tercile of Costs Expected, Last 15 Years	Tercile of Costs Expected, Last 34 Years
R 1 & 4	Middle	Middle
R 2 & 3	Lower	Middle
R 5	Upper	Upper
R 6	Middle	Upper
R 8 & 9	Lower	Lower
R 10 & RFS	Lower	Middle
Total	Middle	Upper

Model Evaluation

Forecast Evaluation

A jackknife or “leave-one-out” approach was used to evaluate the forecast accuracy of the Spring Current Year Forecast Model (SCYFM) used in this forecast. This analysis shows that the root mean squared error of the forecast is \$149 million, calculated over 1995 to 2009 (Table 4). This result can be compared to the Fall Current Year Forecast Model (FCYFM), which was reported in November 2009. The FCYFM had a root mean squared error of \$207 million. Smaller errors imply a more accurate forecast. The mean absolute percent error of the SCYFM forecast is 20 percent, compared to 37 percent for the FCYFM. The SCYFM tended to under-predict by an average of \$14 million, which is smaller than the under-prediction observed for the FCYFM (\$31 million). Finally, the SCYFM correctly predicted the direction of change in emergency suppression expenditures compared to the previous year’s prediction being correct 87 percent of the time (it was wrong only twice, 1996 to 2009). The FCYFM had the same correct direction of change prediction rate (as a point of reference, costs in FY 2010 are expected to be higher than in FY 2009, once Cost Pool charges are factored out). The performance of the SCYFM can be further appreciated by observing its point estimates (approximately the median forecast amount) compared to observed amounts for 1995-2009 (Figure 2). As a comparison, the FCYFM forecasts accompany those shown for the slightly more accurate SCYFM.

Table 4. Forecast statistics for the Spring Current Year Forecast Model (SCYFM) and Fall Current Year Forecast Model (FCYFM).

	SCYFM	FCYFM
Root Mean Squared Error, 1995-2009 (2004 \$ Million)	149	207
Mean Absolute Percent Error, 1995-2009	20	37
Bias, 1995-2009, Predicted Minus Actual (2004 \$ Million)	-14	-31
Correct Direction of Change %, 1996-2009	87	87

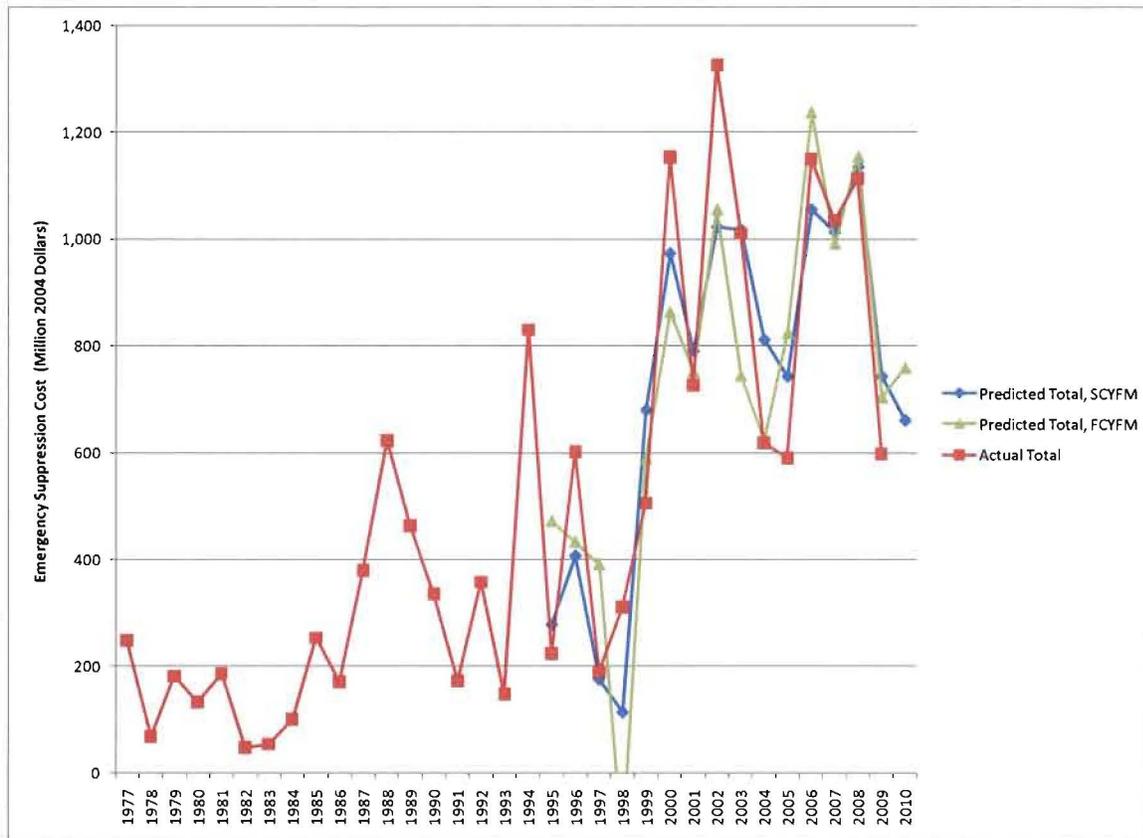


Figure 2. Observed Agency-wide emergency suppression expenditures, 1977-2009, and forecast expenditures using a jackknife procedure, 1995-2009, and forecast levels for 2010 (all costs exclude special Cost Pool charges).

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