Federal Land Assistance, Management, and Enhancement (FLAME) Act Suppression Expenditures for Interior and Agriculture Agencies:

July 2014 Forecasts for Fiscal Year 2014

Supporting Documentation

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Executive Summary

The U.S. Department of Agriculture (USDA) Forest Service is forecast to spend, with 90 percent confidence, between $924 million and $1.61 billion in Fiscal Year (FY) 2014 with a median forecast of $1.27 billion. Excluding cost pools, the FY 2014 Forest Service median forecast is in the upper tercile of expenditures since 2003. The Forest Service July FLAME forecast is more than the March 2014 median ($1.22 billion) and less than the May 2014 median ($1.55 billion) and the September 2013 median ($1.32 billion) for FY 2014.

The U.S. Department of the Interior (DOI) is forecast to spend, with 90 percent confidence, between $302 million and $355 million, with a median forecast of $328 million. DOI expenditures are expected to be in the middle tercile of expenditures since 2005. The July DOI forecast is more than the May 2014 median ($296 million) and less than the March 2014 median ($336 million) and the September 2013 median ($408 million) for FY 2014. The median values in this forecast are within the 90 percent confidence intervals provided in the previous FLAME forecasts for FY 2014 for both agencies.

Overview

With the passage of the FLAME Act in 2009, both the Forest Service and the Department of the Interior are required to produce forecasts of annual suppression expenditures three times during each fiscal year: March, May, and July, with a September outlook for the next fiscal year required when the next fiscal year budget is not approved by Congress and the President by that date. Scientists at the USDA Forest Service Southern Research Station provide these forecasts to both the Forest Service and the DOI.

Forecast

USDA Forest Service

FY 2014 suppression expenditures for the USDA Forest Service are forecast to range, with 80 percent confidence, from $992 million to $1.54 billion, with a median forecast of $1.27 billion. The 90 percent confidence band spans $924 million to $1.61 billion, while a 95 percent band spans $867 million to $1.66 billion. These expenditures include $58 million in estimated cost pool contributions (Table 1). The forecast probability density is shown in Figure 1, and the not-to-exceed levels at a range of probabilities are reported in Table 2. As Table 2 shows, this model

states that there is a 1 percent chance that Forest Service suppression expenditures, including the cost pool, will fall below $806 million. In contrast, there is a 70 percent chance that these expenditures will fall below $1.383 billion.

An analysis of historical real dollar expenditures in suppression contains information about the likely financial magnitude of spending for FY 2014 (Table 3), by Forest Service regional aggregate and in total. An examination of this table reveals that, when compared to expenditures since 2003, the Westwide and Eastern aggregate totals are expected to be in the middle tercile while the Rest of the Forest Service and the Forest Service in total are expected to be in the upper tercile.

Department of the Interior

FY 2014 suppression expenditures for the DOI are forecast to range, with 80 percent confidence, from $309 million to $348 million, with a median forecast of $328 million. The 90 percent confidence band spans $302 million to $355 million, while a 95 percent band spans $295 million to $362 million (Table 4). As in the Forest Service forecast, uncertainty surrounding the DOI forecast for FY 2014 is illustrated with a the probability density graphic (Figure 2) developed with 50,000 Monte Carlo random forecasts. The median forecast expenditure from the Monte Carlo simulation for the Department is within the middle tercile of expenditures since 2005.

Modeling

Modeling Framework for the July 2014 Forecast of FY 2014 Forest Service Expenditures

To meet the statutory requirements of the FLAME Act, the Forest Service developed statistical models based on peer reviewed research[1,2]. These models have been developed for several forecast horizons and are generally specified as a system of equations. Each of the equations contained in the current modeling system represents a statistical relationship between historical expenditures and a set of predictor variables for a particular Forest Service regional aggregate: Westwide (Regions 1-6), Eastern (Regions 8 and 9), and Rest of Forest Service (Region 10 and the Rest of the Forest Service). These equations are estimated using ordinary least squares regression (OLS).

This report is the fourth FLAME forecast issued for FY 2014; previous forecasts for FY 2014 were issued in September 2013, March 2014, and May 2014. The expenditures made by the National Interagency Fire Center, Washington Office, and research stations continue to be modeled as an aggregate, which we label in this report as “RFS” for the Rest of the Forest Service. Data for modeling were annual fiscal year expenditures at the end of each summer month, and they ranged from 2003 to 2013, the only years for which consistent data could be

[1] Prestemon, J.P., K.L. Abt, and K. Gebert. 2008. Suppression cost forecasts in advance of wildfire seasons. Forest Science 54(4):381-396.
[2] Abt, K.L., J.P. Prestemon, and K. Gebert. 2009. Wildfire suppression cost forecasts for the US Forest Service. Journal of Forestry 107(4):173-178.

assembled. To erase the effects of general price inflation, all expenditure data were adjusted to constant 2004 dollars, using the gross domestic product deflator. The statistical models that predict expenditures in the coming fiscal year were identified with extensive research effort. They relate total spending by regional aggregate to lagged measures of drought (Palmer indices), ocean temperatures (the Niño-3 sea surface temperature anomaly), and time.

Equation estimates are shown in Table 5. This table indicates that most models had moderate R^2's, ranging from 0.51 (Rest of Forest Service) to 0.67 (Westwide). Durbin-Watson statistics, designed to detect serial autocorrelation in the residuals of estimated equations, were all within the acceptable (insignificant) or inconclusive range due to the short data series.

Using the equation estimates shown in Table 5 for regional aggregate-level expenditures, we performed a Monte Carlo simulation that produced a probability distribution of forecast expenditures for each regional aggregate and for the agency in total. After the simulation was completed, we adjusted the forecast values to put them in current dollars and then added the estimated contributions to the 2014 wildland fire suppression cost pool ($58 million).

When generating a forecast distribution (see Figure 1), we randomly sampled from actual out-of-sample equation error distributions in ways that accounted for the error and parameter uncertainties in the forecast. These Monte Carlo forecasts, which are repeated 50,000 times, do not produce a precise expenditure estimate for any regional aggregate or in total. Rather, they generate a distribution of estimates. This distribution is summarized as a forecast density distribution (Figure 1), a table reporting a median forecast and the lower and upper bounds of likely observed expenditures (Table 1), and a table of not-to-exceed expenditures by probability levels (Table 2). We also describe where the median forecast value falls within the observed historical expenditures for other years, in real dollar terms, by regional aggregate and in total.

Model fitness is shown in Figure 3 and Table 6. The graph shows how well the July 2014 FLAME Act Forecast Model forecasts out-of-sample using the leave-one-out cross validation method (produced by dropping the observation of the forecast year, and doing this iteratively over the historical data), compared with observed expenditures for the Forest Service, as well as forecasts produced by the September, March, and May FLAME Act Forecast Models. Table 6 shows that the root mean squared error of the model used in this July 2014 forecast of FY 2014 expenditures, when applied to the 2003-2013 period, was $190 million and that it had a positive bias, tending to over-forecast by about $13 million (1 percent). (This bias was not used to adjust the July 2014 forecast for FY 2014.) The model had a Mean Absolute Percent Error of about 15 percent, meaning that the typical forecast averaged 15 percent above or below expenditures actually incurred during the 2003-2013 period. Finally, this model correctly predicted the direction of change in suppression expenditures by the Forest Service 70 percent of the time. The predicted direction of change for FY 2014 compared to FY 2013 is negative (downward) when considered from the median forecast excluding the cost pool (Figure 3).

Modeling Framework for the July 2014 Forecast of FY 2014 Department of the Interior Expenditures

The forecast model for the Department of the Interior (DOI) is based on departmental total expenditure data—i.e., aggregated across all bureaus and geographic regions. The July 2014 FLAME Act Model covered department wide expenditures for fiscal years 2005-2013[3]. We modeled aggregate DOI expenditures using a parsimonious model specification involving the same two Palmer Drought Indices used in the Forest Service models.

The DOI suppression expenditure forecast equation is reported in Table 7. It included the Palmer Drought Index for Forest Service Westwide (Regions 1-6) average value at the beginning of the growing season (March week 1) and Region 8 in May week 4, and an intercept. The estimated equation explained 97 percent of the variation ($R^2 = 0.97$) in annual DOI suppression expenditures over the historical time period, 2005-2013. The Durbin Watson statistic indicated no evidence (DW=1.5) of residual autocorrelation in the model estimation errors.

Model fitness for the July FLAME Act Forecast Model for DOI is reported in Table 8. As in the case of the Forest Service July FLAME Act Forecast Model, the DOI July FLAME Act Forecast Model was evaluated using a cross-validation procedure. This July forecast model had a root mean squared error of about $13 million and had a bias of negative $182 thousand (-0.06 percent) calculated over 2005-2013 (this historical bias was not used to adjust the 2014 forecast). The model had a Mean Absolute Percent Error of 4 percent from 2005-2013. It correctly predicted the direction of change in suppression expenditure for the agency from one year to the next100 percent of years 2005-2013. The predicted direction of change for FY 2014 compared to FY 2013 is negative (downward) when considered from the median forecast (Figure 4).

[3] Although geographical and agency disaggregated data are available for recent years (since the early 2000's), there are insufficient data for modeling by geographic region within the Department. David Burley, Budget Analyst with the Office of Wildland Fire in Boise, has recently (6/2/2014) assisted with obtaining bureau level data that may be useful in future forecasts, only the total DOI-wide expenditures were used in this forecast.

Table 1. July 2014 FLAME Act forecasts of Fiscal Year 2014 suppression expenditures of the USDA Forest Service in total by month in millions of current (FY 2014) dollars.

	Westwide	Eastern	RFS	Total
Median Forecast	697	45	463	1,265
80% Confidence Limit Lower Bound	379	14	257	992
80% Confidence Limit Upper Bound	1,014	79	668	1,537
90% Confidence Limit Lower Bound	340	14	199	924
90% Confidence Limit Upper Bound	1,054	88	726	1,606
95% Confidence Limit Lower Bound	320	14	149	867
95% Confidence Limit Upper Bound	1,074	97	776	1,662

This table includes the Fiscal Year 2014 contributions to the wildland fire suppression cost pool, expected to be $58 million, which are added to the agency-wide total.

Table 2. July 2014 FLAME Act forecasts of Fiscal Year 2014 suppression expenditures of the USDA Forest Service, probability of falling below specified amount in millions of current (FY 2014) dollars*.

Probability (Percent)	Total
1	$806
5	924
10	992
20	1,079
30	1,145
40	1,207
50	1,265
60	1,323
70	1,383
80	1,450
90	1,537
95	1,606
99	1,725

*This column of totals includes the Fiscal Year 2014 contributions to the wildland fire suppression cost pool, expected to be $58 million.

Table 3. July 2014 FLAME Act forecasts of Fiscal Year 2014 suppression expenditures of the USDA Forest Service by regional aggregate and in total by tercile*.

	Tercile
Westwide	Middle
Eastern	Middle
Rest of Forest Service	Upper
Total	Upper

* Note: Historical wildland fire suppression cost pool expenditures are assumed to be zero in all year expenditure totals used in these rankings. Comparisons across years are in real (2004) dollars.

Table 4. July 2014 FLAME Act forecasts of Fiscal Year 2014 suppression expenditures of the Department of the Interior in millions of current (FY 2014) dollars.

	Total
Median Forecast	$328
80% Confidence Limit Lower Bound	309
80% Confidence Limit Upper Bound	348
90% Confidence Limit Lower Bound	302
90% Confidence Limit Upper Bound	355
95% Confidence Limit Lower Bound	295
95% Confidence Limit Upper Bound	362

Table 5. Ordinary least squares regression equation estimates used in the July 2014 forecast of FY 2014 suppression expenditures of the USDA Forest Service*.

Dependent Variable	Independent Variable	Coefficient	Std. Error	t-Statistic	Prob.	R2	Durbin Watson
Westwide	Constant	684,190,593	63,374,512	10.80	0.0001	0.67	2.73
	Palmer Drought Index (West)	-115,292,351	47,881,758	-2.41	0.0234		
	March Week 1 Nino-3 SSTA in April	-344,968,798	172,070,321	-2.00	0.0555		
Eastern	Constant	40,692,543	5,892,778	6.91	0.0001	0.54	2.88
	Palmer Drought Index (Region 8)	-14,481,375	4,488,177	-3.23	0.0034		
	May Week 4						
Rest of Forest Service	Constant	-62,977,998,053	20,611,989,950	-3.06	0.0051	0.51	1.67
	Time	31,459,127	10,264,923	3.06	0.0050		

Note: The dependent variable is the regional aggregate annual real dollar expenditures.

Table 6. Cross-validation of the ordinary least squares regression model used in the July 2014 forecast of FY 2014 suppression expenditures of the USDA Forest Service calculated over data from FY 2003-2013 in current (FY 2014) dollars.

	July FLAME Act Forecast Model
Root Mean Squared Error, $, 2003-2013	189,882,768
Bias, $, 2003-2013, Predicted Minus Actual	12,577,865
Bias (%)	1.19
Mean Absolute Percent Error, %, 2003-2013	15
Correct Direction of Change, %, 2004-2013	70

Table 7. Equation estimate used in the July 2014 Forecast of FY 2014 suppression expenditures of the Department of the Interior*.

Variable	Coefficient	Std. Error	t-Statistic	Prob.	R^2	Durbin Watson
Constant	3.0E+08	6.0E+06	50.07	0.0001	0.98	1.49
Palmer Drought Index (Westwide March Week 1)	-3.4E+07	4.5E+06	-7.63	0.0001		
Palmer Drought Index (FS Region 8 May Week 4)	-4.1E+07	3.7E+06	-11.21	0.0001		

*Note: The dependent the Department's annual real dollar expenditures.

Table 8. Cross-validation of the equation used in the July 2014 forecast of FY 2014 suppression expenditures of the Department of the Interior calculated over FY 2005-2013.

	July FLAME Act Forecast Model
Root Mean Squared Error, 2005-2013 (2014 $)	16,250,862
Bias, 2005-2013, Predicted Minus Actual (2014 $)	-221,115
Bias (percent)	-0.06
Mean Absolute Percent Error, 2005-2013	4
Percent Correct Direction of Change, 2006-2013	100

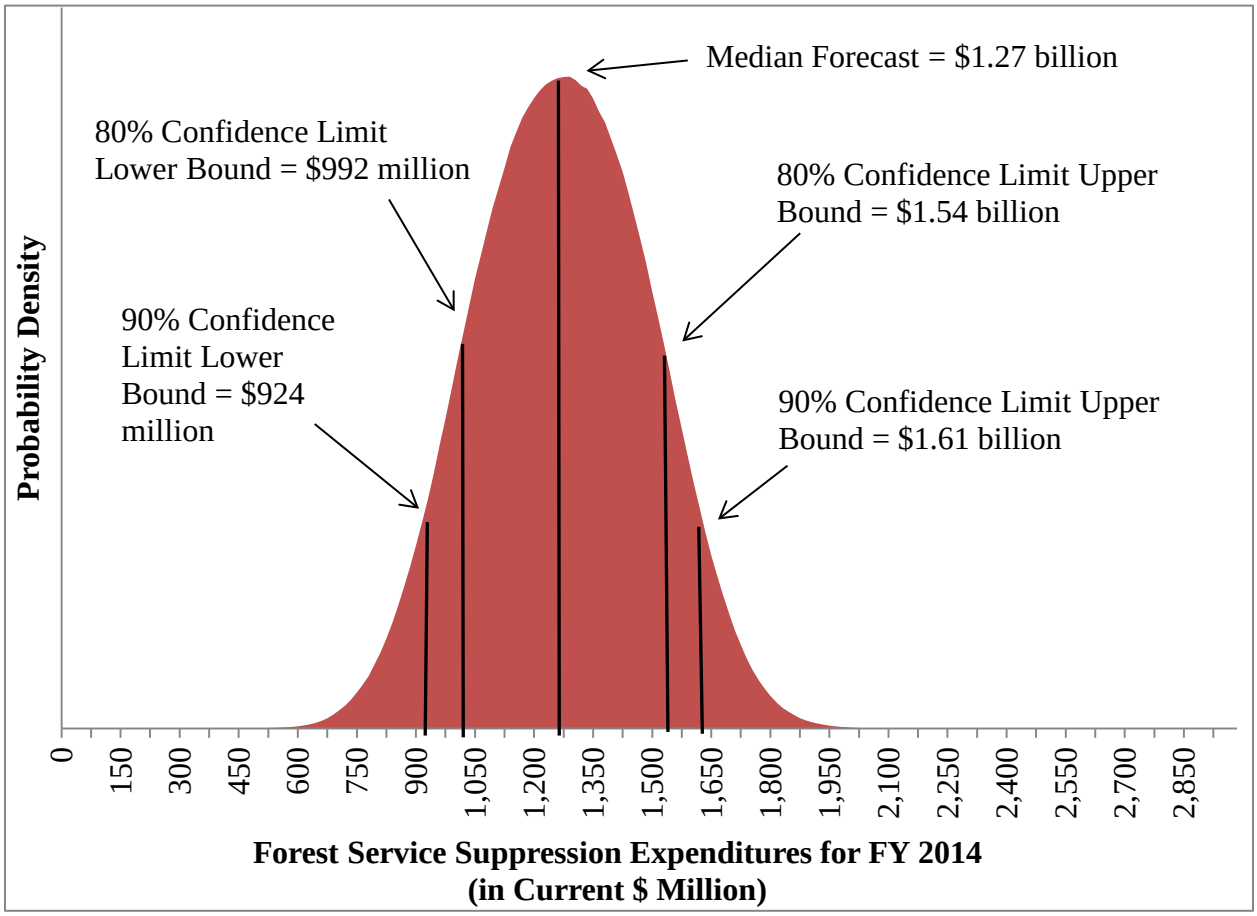

Figure 1. USDA Forest Service suppression expenditure forecast probability density, Fiscal Year 2014, July 2014 FLAME Act Forecast Model. (Note: Fiscal Year 2014 wildland fire suppression cost pool expenditures are included at their expected level of $58 million in this probability density display.)

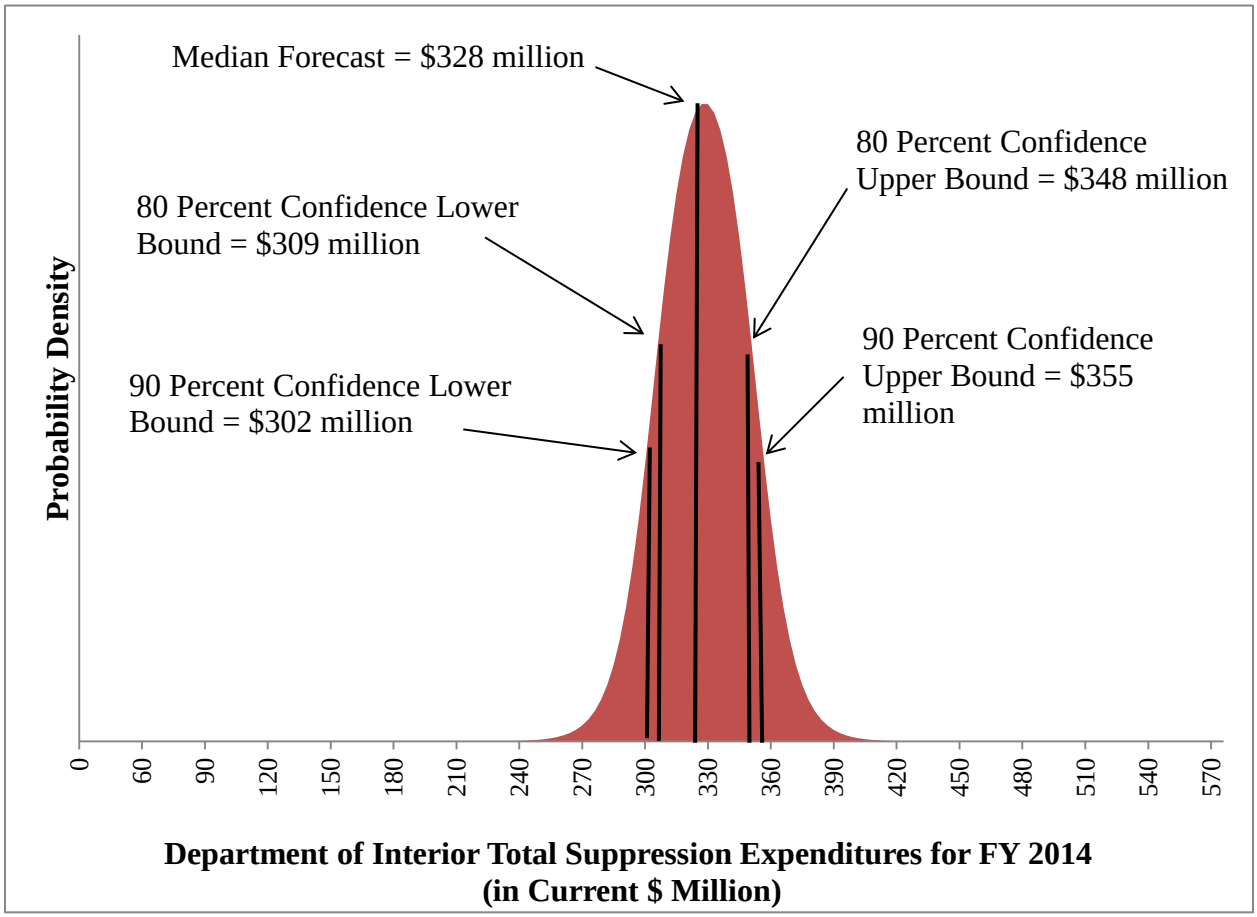

Figure 2. Department of the Interior suppression expenditure forecast probability density, Fiscal Year 2014, July 2014 FLAME Act Forecast Model.

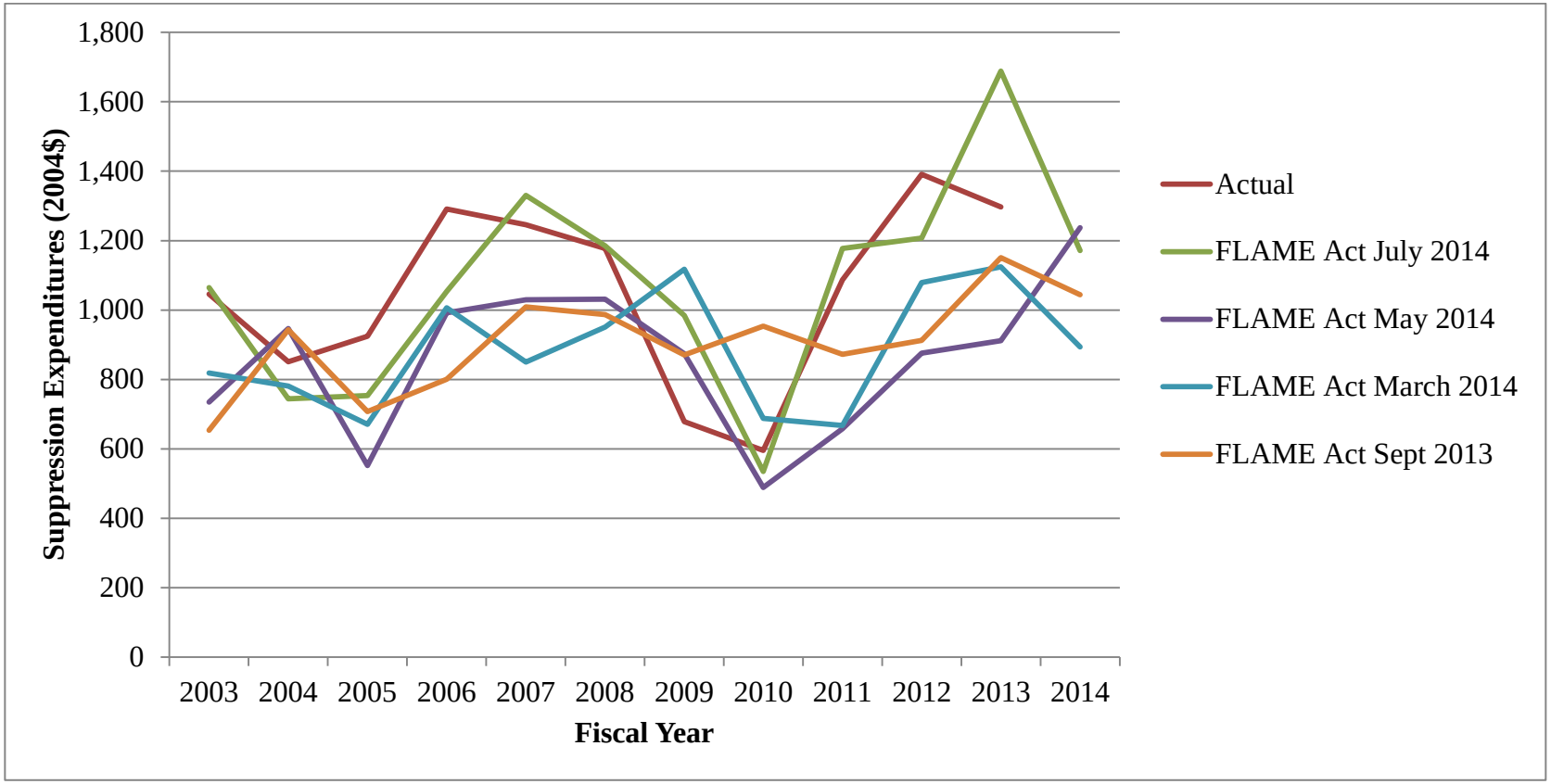

Figure 3. Observed historical USDA Forest Service suppression expenditures (2003-2013) and the forecasts of these expenditures (2003-2014) using the July 2014 FLAME Act Forecast Model. All forecasts for each fiscal year are sums across the point estimates of each regional aggregates' expenditures generated with a cross-validation procedure. (Note: values are in constant 2004 dollars and exclude the wildland fire suppression cost pool expenditures.)

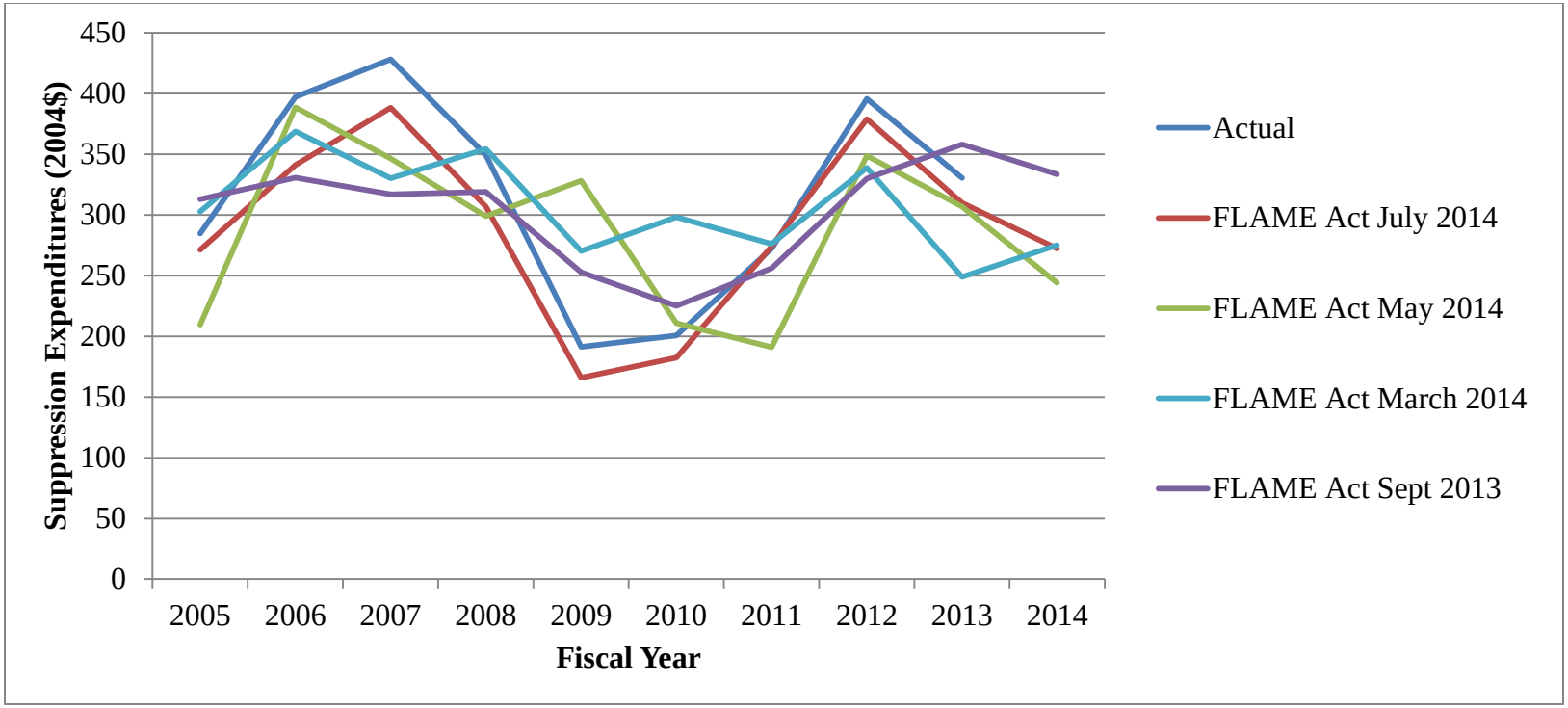

Figure 4. Observed historical Department of the Interior suppression expenditures (2005-2013) and the forecasts of these expenditures (2005-2014), using the July 2014 version of the July FLAME Act Forecast Model. All forecasts for each fiscal year are the point estimates generated with a cross-validation procedure. (Note: values are in constant 2004 dollars)