Lower 48

Lower 48 Overview

Consumption and carbon emission estimates from biomass burning in the Lower-48 combine spatial fuel datasets and fire effects models that together describe the primary interacting physiographic and environmental compartments involved in fires. The ultimate goal is to create a generalized framework for estimating consumption and emissions from historical burn data then expanding the methodology into a predictive context for evaluating present and future consumption/emission probabilities. In addition, the utility of post-fire remote sensing burn ratios (i.e Differenced Normalize Burn Ratio [dNBR]) for assessing biomass consumption will be tested by combining spatial fuel consumption models with dNBR images to search for spatial correlations between fuel-type, fuel moisture, and burn severity. Principle input data, data characteristics, fire effects models, and results are described below.

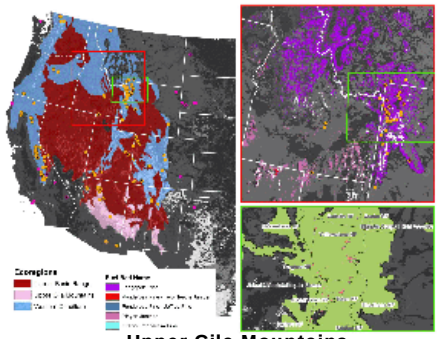
Spatial Datasets

FCCS (Fuel Characteristics Classification System)

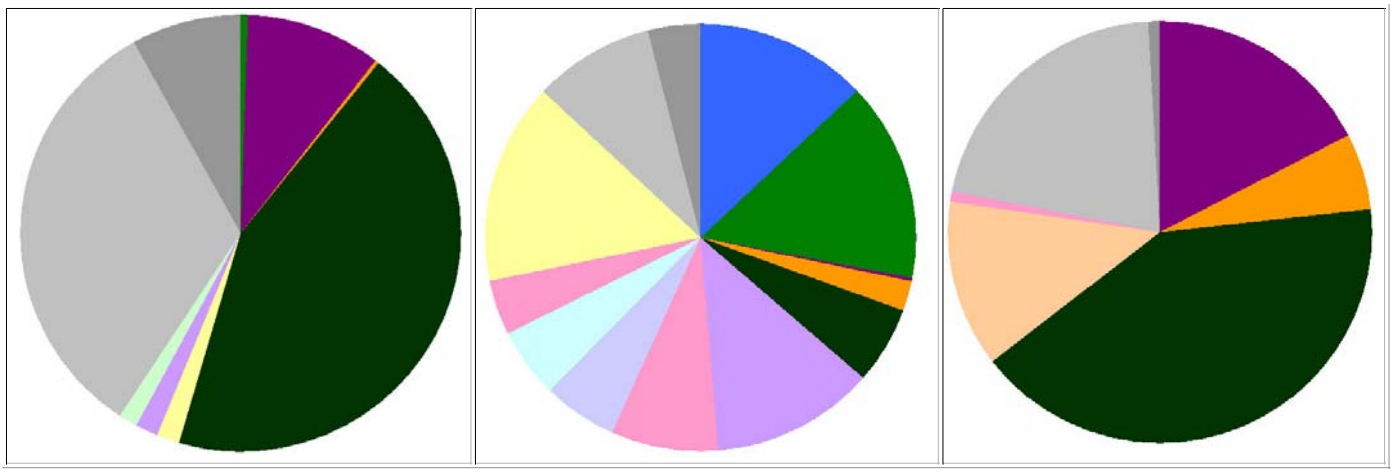
FCCS is a 1-km fuelbed map for the contiguous United States. Fuel attributes contained within each fuel code provide the fuel loading inputs for the Consume consumption model. A fact sheet for the FCCS can be found here. Please visit the FERA (Fire and Environment Research Applications) webpage for complete FCCS system documentation and references.

Right: FCCS (Fuel Characteristics Classification System) fuel beds for the Western United States overlayed by Omernik's ecoregions. Also visible in the graphic are example burn perimeters derived using dNBR. The current fire database contains over 250 fire perimeters and dNBR images.

Below: FCCS fuel bed composition by ecoregion for the three main Western U.S. ecoregions examined in this study.



Interior Basin Range	Western Cordillera	Upper Gila Mountains

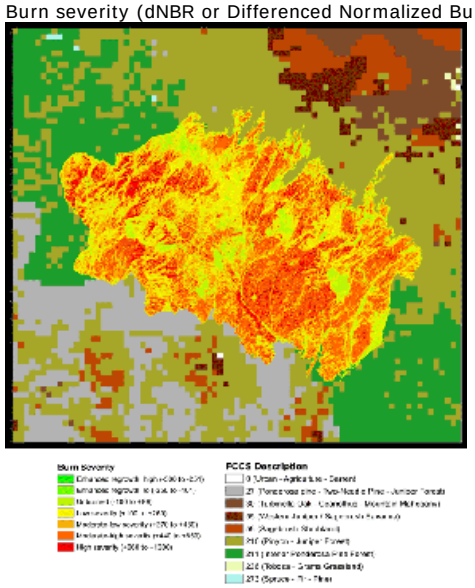


- Lodgepole pine forest
- Ponderosa pine - Two-needle pine - Juniper forest
- Pinyon - Juniper forest
- Douglas-fir - ponderosa pine forest
- Pacific ponderosa pine forest
- Subalpine fir - Engelmann spruce forest - Douglas-fir forest
- Subalpine fir - Lodgepole pine - Whitebark pine - Engelmann spruce forest
- Non-forest/Shrubland/Grassland
- Ponderosa pine - Jeffrey pine forest
- Interior ponderosa pine forest
- Pacific ponderosa pine - Douglas-fir forest
- Western hemlock - Western redcedar - Douglas-fir forest
- Western juniper / Huckleberry oak forest
- Engelmann spruce - Douglas-fir - White fir - Interior ponderosa pine
- Other forest types
- Urban - Agriculture - Barren

USGS Burn Severity Data

Burn perimeters and dNBR images for post-2000 fires are freely distributed by the USGS via the Monitoring Trends in Burn Severity (MTBS) effot. Data is downloadable and comes in GIS-ready formats. Visit the project's website for more information.

Burn severity (dNBR or Differenced Normalized Burn Ratio) is a remote sensing change detection technique utilizing the two Landsat TM/ETM+ bands most responsive to fire-induced environmental change. dNBR is best described as the magnitude of environmental change occurring during a fire. Attempting to link dNBR to biomass consumption is one of the primary challenges this study addresses. Click here for an example summary of dNBR response by fuel type for three large fires. At ***left***, burn severity mapped using the dNBR approach by the National Burn Severity Mapping program is compared to the Fuel Characteristic Classification System (FCCS) fuelbed map, developed by FERA, to learn the distribution of fuels burned at various severities.



$$NBR = \frac{R4 - R7}{R4 + R7}$$

$$dNBR = NBR_{prefire} - NBR_{postfire}$$

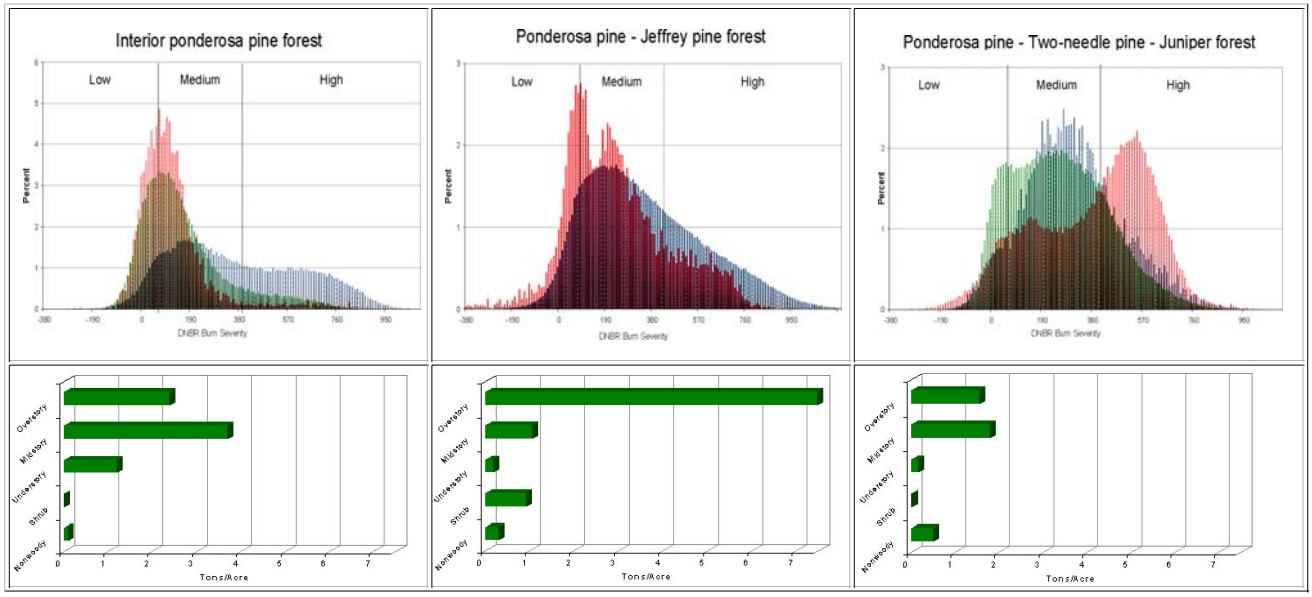
Back to top ^

Data Characteristics

Burn Severity and Forest Structure by Fuel Bed

Three main FCCS fuel types in the western U.S. are characterized below by dNBR burn severity distribution (***top***) by ecoregion (from 261 fires from 1984-2005) and forest structure (***bottom*** - from FCCS analysis).

- Interior Basin Range
- Western Cordillera
- Upper Gila Mountains

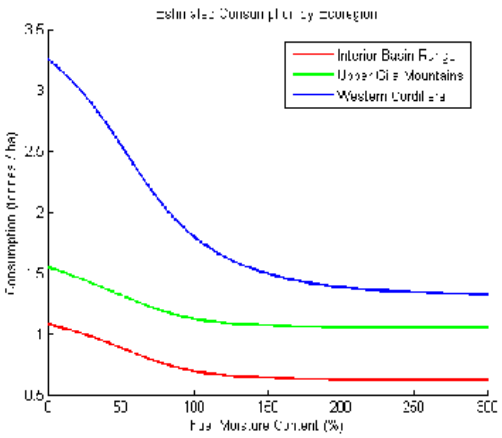


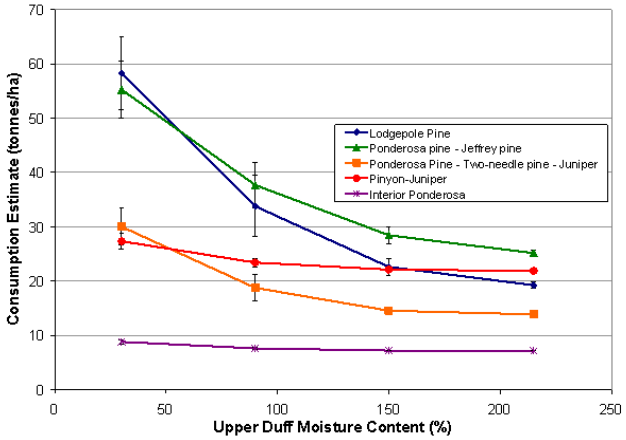
Back to top ^

Fire Effects Models

Consume 3.0

The Consume 3.0 model developed by FERA is capable of making biomass consumption estimates using FCCS descriptors and fuel moisture as model inputs. A goal of this project was to make the Consume model spatially explicit to analyze the geographic distribution of consumption patterns. More information on Consume can be found here. Consumption as a function of fuel moisture for the three ecoregions of interest in the Lower-48 (below left) are shown below.





Similarly, ***above right*** shows consumption as a function of fuel moisture for the five most common fuel beds in the Western U.S. but divided into categories to show the use dNBR severity classes as a surrogate for fuel moisture. Error bars represent the range of modeled consumption within each severity class.

Below are charts showing the amounts of area burned for seven burn severity classes by fuelbed (***top***) and ecoregion (***bottom***) for a preliminary set of fires mapped by MTBS (97 fires).

FCCS fuelbed code	1	2	3	4	5	6	7	Total
22	31	566	11,579	13,846	9,989	9,385	12,167	57,565
27	11	150	2,947	8,211	9,068	14,552	3,917	38,856
37	47	601	10,790	14,599	9,456	6,458	3,241	45,193
210	125	684	24,197	35,118	28,098	26,291	7,688	122,201
211	22	205	11,064	36,622	32,109	37,389	14,956	132,367
Total	236	2,207	60,577	108,396	88,719	94,075	41,970	396,180

EcoregionName	1	2	3	4	5	6	7	Total
Interior Basin Range	71	651	16,787	21,245	20,832	24,412	7,861	91,858
Upper Gila Mountains	17	303	25,259	55,841	48,945	56,826	17,042	204,232
Western Cordillera	427	3,274	52,225	70,187	50,469	40,871	37,093	254,546
Total	515	4,228	94,271	147,273	120,246	122,109	61,995	550,637

Back to top ^

Results

Applying Consume 3.0 to dNBR Values

Equating dNBR burn severity classes to Consume 3.0 fuel moisture classes as above yielded consumption estimates for fuel types and. ecoregions. The table ***below*** shows the distribution and consumption level of each fuel type by ecoregion.

Ecoregion	FCCS Category	Area Estimate (sq. km)	Area (% of ecoregion)	Fuel Consumption (tonnes/ha)
	Other forest types	844.9	15.3	63.7
	Ponderosa pine - Jeffrey pine forest	825.3	14.9	28.2
	Lodgepole pine forest	728.4	13.1	22.4
	Pacific ponderosa pine - Douglas-fir forest	676.9	12.2	17.6
	Douglas-fir - ponderosa pine forest	452.8	8.2	50.3
Western	Western hemlock - Western redcedar - Douglas-	314.9	5.7	73.6
Cordillera	Pinyon - Juniper forest	314.4	5.7	7.1
	Pacific ponderosa pine forest	281.4	5.1	25.3
	Western juniper / Huckleberry oak forest	233.0	4.2	13.5
	Interior ponderosa pine forest	128.5	2.3	22.1
	Ponderosa pine - Two-needle pine - Juniper forest	12.1	0.2	14.4
	Non-forest/Shrubland/Grassland	509.1	9.2	4.6
	Urban - Agriculture - Barren	217.3	3.9	0.0
	TOTAL	**5539.1**		**30.5**
	Pinyon - Juniper forest	509.8	41.1	7.1
Upper	Ponderosa pine - Two-needle pine - Juniper forest	215.6	17.4	13.8
Gila	Engelmann spruce - Douglas-fir - White fir -	161.5	13.0	38.9
Mountains	Interior ponderosa pine forest	72.6	5.8	21.9
	Subalpine fir - Engelmann spruce - Douglas-fir -	8.0	0.6	56.3
	Non-forest/Shrubland/Grassland	263.4	21.2	2.7
	Urban - Agriculture - Barren	9.6	0.8	0.0
	TOTAL	**1240.4**		**12.6**
	Pinyon - Juniper forest	624.8	43.4	7.1
	Ponderosa pine - Two-needle pine - Juniper forest	144.9	10.1	14.4
	Other forest types (7 types)	26.4	1.8	36.2
Interior	Subalpine fir - Lodgepole pine - Whitebark pine -	24.2	1.7	34.4
Basin	Pacific ponderosa pine forest	20.0	1.4	25.3
Range	Ponderosa pine - Jeffrey pine forest	7.3	0.5	25.0
	Interior ponderosa pine forest	5.0	0.3	21.9
	Lodgepole pine forest	0.5	0.0	18.5
	Non-forest/Shrubland/Grassland	469.3	32.6	2.9
	Urban - Agriculture - Barren	117.8	8.2	0.0
	TOTAL	**1440.2**		**7.3**

Estimates of typical fuel consumption by fire size per ecoregion are shown ***below***. These estimates were made by assuming typical fuel type distribution and consumption levels as described in the table ***above.*** Uncertainty ranges were derived by extracting the upper and lower limits in the range of modeled consumption within each severity class (as respresented by the error bars in the consumption graph to the right above).

	Consumption Estimates by Fire Size (tonnes)		
Ecoregion\ Fire size:	Small (1k ha)	Average (4k ha)	Large (50k ha)
Western Cordillera	28,880 - 33,100	115,520 - 132,400	1,444,000 - 1,655,000
Interior Basin Range	7,110 - 7,710	28,440 - 30,840	355,500 - 385,500
Upper Gila Mountains	12,480 - 12,850	49,920 - 51,400	624,000 - 642,400

Back to top ^