2017 Alaska Fire Emissions Inventory

Department of Environmental Conservation
Air Quality Division
Non-Point Mobile Sources Program

June 2018

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2017 Alaska Wildfire Emissions Inventory

1 INTRODUCTION

The Alaska Department of Environmental Conservation (DEC) collects, reviews, tracks, and summarizes burn data for annual Alaska Enhanced Smoke Management Plan (ESMP) emissions inventory reports to be distributed to the Alaska Wildfire Coordinating Group (AWFCG), the US Environmental Protection Agency (EPA), and the Western Regional Air Partnership (WRAP).

This report fulfills the responsibility for reporting 2017 prescribed fire emissions, as required by the ESMP. It provides information about the DEC Open Burn Applications for prescribed burns approved by DEC for 2017 and it reports statewide wildfire emissions for the same year.

1.1 Fire Management in Alaska

The Alaska Interagency Coordination Center (AICC) is the Geographic Area Coordination Center for Alaska. Located on Fort Wainwright, near Fairbanks, the AICC serves as the focal point for initial response, resource coordination, logistics support, and predictive services for all state and federal agencies involved in wildfire management and suppression in Alaska.

AICC operates on an interagency basis; cooperators include Bureau of Land Management (BLM), State of Alaska Department of Natural Resource's Division of Forestry (DNR/DOF), United States (US) Forest Service (USFS), National Park Service (NPS), Bureau of Indian Affairs (BIA), and the US Fish and Wildlife Service (USFWS). AICC collects wildfire data and prepares daily situation reports.

DEC manages permits for prescribed burns and collects and reports air quality data for wild and prescribed fires over 40 acres. The Department of Natural Resources Division of Forestry issues permits for prescribed burns of less than 40 acres.

The AICC and AWFCG coordinate fire management planning, preparedness, suppression, prescribed fire, and related activities. For the purposes of fire suppression, the BLM, USFS, and DNR/DOF each take responsibility for managing fires in regions of the State, regardless of ownership. The State of Alaska is divided into 14 Fire Management Zones (Figure 1). This approach reduces the duplication of efforts and encourages cooperation between state and federal agencies, promoting efficiency and cost effective use of facilities and resources to manage fires.

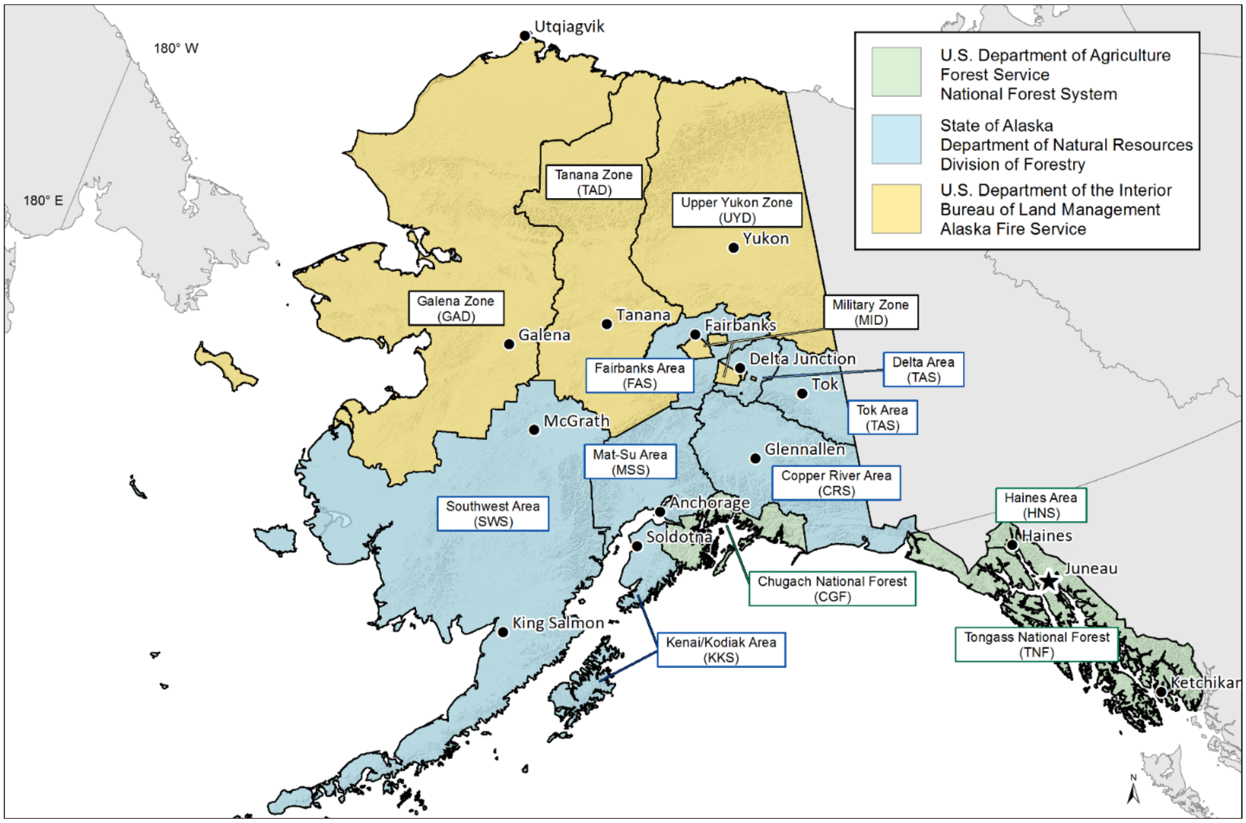

Figure 1 – Fire Management Zone Map

1.2 Fire and Air Quality

DEC's Air Quality Division tracks wildfires and regulates prescribed fires from an air quality perspective and provides emissions data from the fires to the EPA on an annual basis.

Smoke is made up of a wide range of chemical compounds, including criteria pollutants. Criteria pollutants are regulated by the EPA to provide protection for public health and the environment. National air quality standards specify allowable concentrations in ambient air. Smoke also impairs visibility. Local impairment can be severe and contribute to unsafe driving conditions, health issues, and regional impairment contributes to haze that obscures vistas.

The pollutants inventoried for this report along with the reasons for including the pollutants are listed in Table 1.

Table 1 – Pollutants Inventoried

Pollutant	Abbreviation	Reason for tracking
Fine particulate matter	$PM_{2.5}$	Criteria pollutant
Coarse particulate matter	PM_{10}	Criteria pollutant
Elemental carbon	EC	Visibility impairment
Organic carbon	OC	Visibility impairment
Sulfur dioxide	SO_2	Criteria pollutant
Oxides of nitrogen	NO_X	Criteria pollutant
Volatile organic compounds	VOC	Hazardous air pollutant
Methane	CH_4	Hazardous air pollutant
Ammonia	NH_3	Visibility impairment
Carbon monoxide	CO	Criteria pollutant

Fine particulate matter ($PM_{2.5}$) is the primary pollutant of concern from wildland fires. $PM_{2.5}$ comprises all airborne particles with an aerodynamic diameter less than 2.5 microns. Because $PM_{2.5}$ is based on size, not chemical composition, it can be made up of a wide range of chemical compounds. Typically, particles in this size range result from combustion such as wildland fires, power plants, engines, wood stoves, heaters, and vehicle exhaust. Due to the small size of the particles, they are inhaled deeply into the lungs, increasing the probability of cardiovascular and respiratory health problems.

1.3 Alaska Enhanced Smoke Management

DEC, in coordination with the AWFCG, developed the ESMP to reduce smoke impacts from prescribed burns in Alaska. The current ESMP and accompanying volume of appendices were adopted by the AWFCG in June 2015. DEC adopted the ESMP as part of a Regional Haze State Implementation Plan (SIP) amendment on December 17, 2015 and submitted it formally to the EPA on March 10, 2016. Minor updates to the Regional Haze SIP regarding ESMP were approved and became effective May 14, 2018.

The ESMP helps DEC protect air quality and human health under federal and state law, reflects the Clean Air Act requirement to improve visibility in Class I areas, and is an important component of Alaska's Regional Haze SIP.

1.4 Open Burn Approvals

Due to the health and visibility effects of smoke, DEC requires anyone burning vegetation over 40 acres within one year to obtain an air quality approval, in the form of a prescribed burn permit before burning activities occur. Open burn approvals outline steps to minimize impacts from smoke such as weather monitoring, emission reduction techniques, and consideration of sensitive features like roads, population centers, schools, and airports where smoke can impact health and visibility. Open burn approvals also require permittees to work with the DEC meteorologist and to submit post burn reports when the prescribed burns are completed. The post-burn reports support DEC's efforts to track and inventory pollutants.

In 2017, DEC granted five approvals for prescribed open burns for land clearing purposes and 48 approvals for training which required a black smoke burn approval (mainly for firefighting training). Resource agencies submitted post burn reports for ten prescribed fires. AICC reported three open burns less than 40 acres that did not require a permit from DEC. These burns did not submit a post burn report; however, they are included in the emission inventory calculations.

There were no known adverse effects to Sensitive Areas or to Class I Areas as a result of conducting prescribed burns.

2 INVENTORY METHODOLOGY

To prepare the 2017 wildfire emissions inventory, DEC used the Wildland Fire Emission Template prepared in 2006 by Air Sciences. The template is an Excel spreadsheet prepopulated with formulas and emission factors to calculate wildland fire emissions. The user enters basic information about each fire and assigns fuel loading factors that defines the amount of vegetation per acre. The inputs include:

- Fire name
- Acres
- Start date
- Out date
- Vegetation type
- Prescribed or wildfire
- Broadcast or piles
- For prescribed fires, vegetation category determines emission reduction technique effectiveness

As in previous years, AICC provided this data to DEC at the end of the year. Fuel loading factors were determined using either the Basic Method or the LANDFIRE (Landscape Fire and Resource Management Planning Tools) method. These methods are described in sections 2.1 and 2.2.

2.1 __Basic Method__

For fires with a vegetation type listed in the AICC dataset, DEC assigned a fuel loading factor. DEC assumed that all fires without a vegetation type listed were grass fires. Table 2 shows the fuel factor name and the fuel loading factor assigned to vegetation types.

Table 2 – Fuel Loading Factors

Fuel Factor Name	Wildfire Loading Factor - tons per acre(tpa)	Prescribed Loading Factor - tpa
Western grasses (annual)	0.5	0.5
Intermediate brush	15	15
Short needle (heavy dead)	43.5	25.6
Western grasses (perennial)	0.75	0.75
Alaskan black spruce	57.57	48.76
Hardwood litter (summer)	3.05	3.05
Tundra	19.3	19.05

2.2 ***LANDFIRE Method***

Large fires can start in one vegetation type, and burn through others, thus the AICC provides more detailed vegetation data under the LANDFIRE system. The calendar year 2017 had 340 wildfires which totaled 653,145 acres. DEC uses the LANDFIRE method to more accurately represent either the 25 largest fires recorded or 90% of the total acres burnt, whichever is less. In 2017, the 19 largest wildfires represented greater than 90%, so these fires were estimated using the LANDFIRE method. Table 3 shows the five largest wildfires from 2017 and their corresponding basic fuel factor. For the largest 19 fires, the average LANDFIRE fuel factor was 37.01 as opposed to 46.16 under the basic method. Representation of the largest wildfires with the LANDFIRE method resulted in a reduction of 25,428 tons of $PM_{2.5}$ being reported; a reduction of 20%.

Table 3 – Five Largest Fires in 2017

Fire Name	Acres	Basic Method Fuel Factor	Primary Fuel
Campbell River	93,520.3	57.57	Alaskan black spruce
White Mountain Creek	78,857.9	57.57	Alaskan black spruce
Nowitna	55,273.5	0.5	Western grasses (annual)
Bear Mountain	46,714.6	57.57	Alaskan black spruce
Boulder Creek	40,906.4	57.57	Alaskan black spruce
Sum:	315,272.7		

Whereas the Basic Method identifies a singular vegetation type and assigns that fuel factor to represent the entirety of the fire, the LANDFIRE Method breaks the landscape into smaller, more representative fractions, assigning each zone a vegetation type and its corresponding fuel factor. Once the fractional areas, defined as the zones area divided by the total fire area, are found, they are multiplied by the corresponding fuel factor (Appendix Table 2) to find the fuel contribution. This value corresponds with the representative fuel factor for the total fire, it is then multiplied by the original fire acreage to give the total tonnage of vegetation burned. While this method is much more time intensive than the Basic Method, it can be beneficial when dealing with the largest fires because it more accurately represents the fuel loading.

LANDFIRE fuel factors are the average of two Basic method fuel factors. For example, the Western North American Boreal spruce-lichen woodland has a fuel factor of 22.13 tons per acre; an average of western grass (0.75 tons per acre) and short needle (43.5 tons per acre). These two averaged fuels are listed as Fuel Factor 1 and Fuel Factor 2 in Appendix table 2.

The LANDFIRE fuel factors are especially helpful for fires that burn a variety of fuels because the fuel factor more accurately represents the true fuels present on the landscape instead of a blanket designation representing the entire fire.

LANDFIRE fuel factors can differ considerably from the Basic Method fuel factors as they are generally lower in value. For 2017, one composite fuel factor was developed that covered all of the 19 largest fires. LANDFIRE 2017 composite value was lower than their Basic Method values. 2017 composite fuel factor for the 19 biggest fires used for calculations of emissions from these fires is 37.01.

2.3 Temporal Adjustments

The Wildland Fire Emission Template assigns emissions in tons to certain months based on a fire's start and end dates which may produce misleading results unless temporal adjustments are made to better reflect the period where most emissions occurred. The template averages the calendar start and end dates then assigns the emissions to the month of the averaged date. This may not accurately reflect the time period a fire actually produced the most emissions because fires may not be declared extinguished or 'out' until long after the majority of the active combustion occurred. During 2017, no fires needed to be recalculated in such a way and it is assumed that the averages of the start and out dates were accurate enough for the purposes of this report.

2.4 Prescribed Fires

Two sources provide information on prescribed fires: the AICC dataset and post burn reports submitted to DEC by permittees or organizations that conducted the burns. The AICC dataset and post burn reports recorded 13 prescribed burns totaling 30,355 acres. Ten fires were over 40 acres and three were under 40 acres. DEC received ten post burn reports applicable to prescribed fires over 40 acres in size. The largest prescribed fire was the DTAW Oklahoma Impact Area fire which was 25,000 acres (82% of the total acreage burned by prescribed fires).

3 EMISSIONS and ACREAGE

3.1 Total Acres and Emissions

During 2017, wild and prescribed fires burned a combined 683,500 acres. While this is a 30% increase over 2016 (520,411 acres), 2017 total area burned is just 13% of 2015 area burned (5,150,673 acres). Figure 2 shows the $PM_{2.5}$ emissions and acreage for both wild and prescribed fires. Wildfires overwhelmingly dominated both the acres burnt and tons $PM_{2.5}$ emitted.

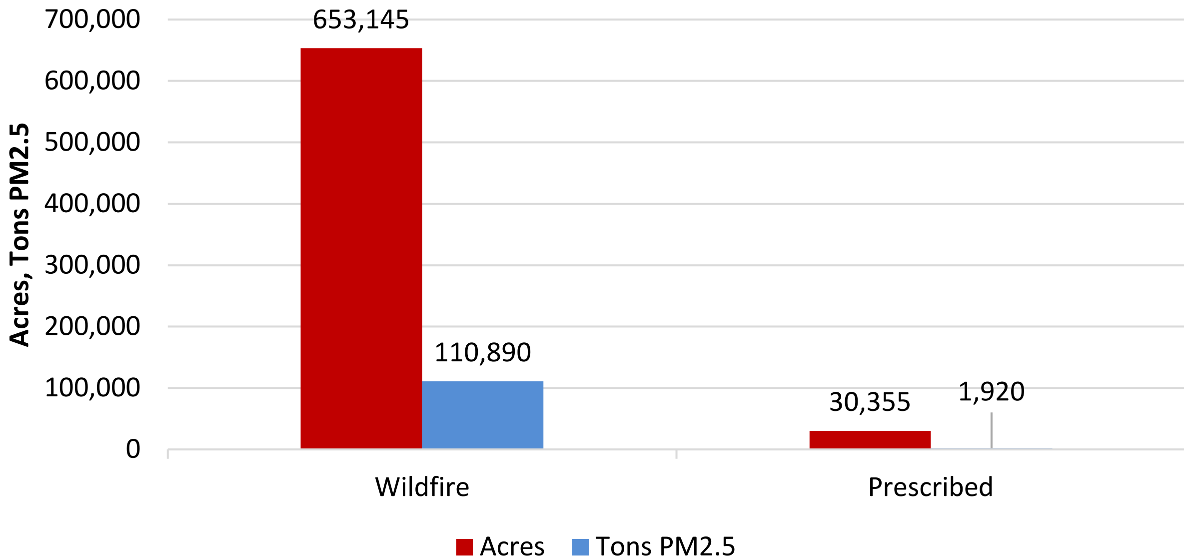

Figure 2 – Wild and Prescribed Area Burned and $PM_{2.5}$ Emissions

Prescribed fires produced proportionally fewer emissions than the wildfires for two main reasons:

- Prescribed fires are intentionally carried out under controlled conditions with the goal of producing fewer emissions.
- This year's prescribed fires were largely grass fires. Grass produces substantially fewer emissions than fires with higher fuel loads.

Figures 3 and 4 compare prescribed and wildfire emissions to the area burned over the last decade. Both categories of fire vary widely from year to year. For prescribed fires, the variation depends on need and the agencies' ability to accomplish the fires. Utilizing the right weather conditions plays an important role in agencies' decisions to burn.

The area burned each year by wildfire varies more than the area burned by prescribed fires, historically ranging from under 10,000 to several million acres. In 2017, wildfires burned 653,145 acres producing 110,890 tons of $PM_{2.5}$. Well timed rains in the interior kept most wildfire activity manageable.

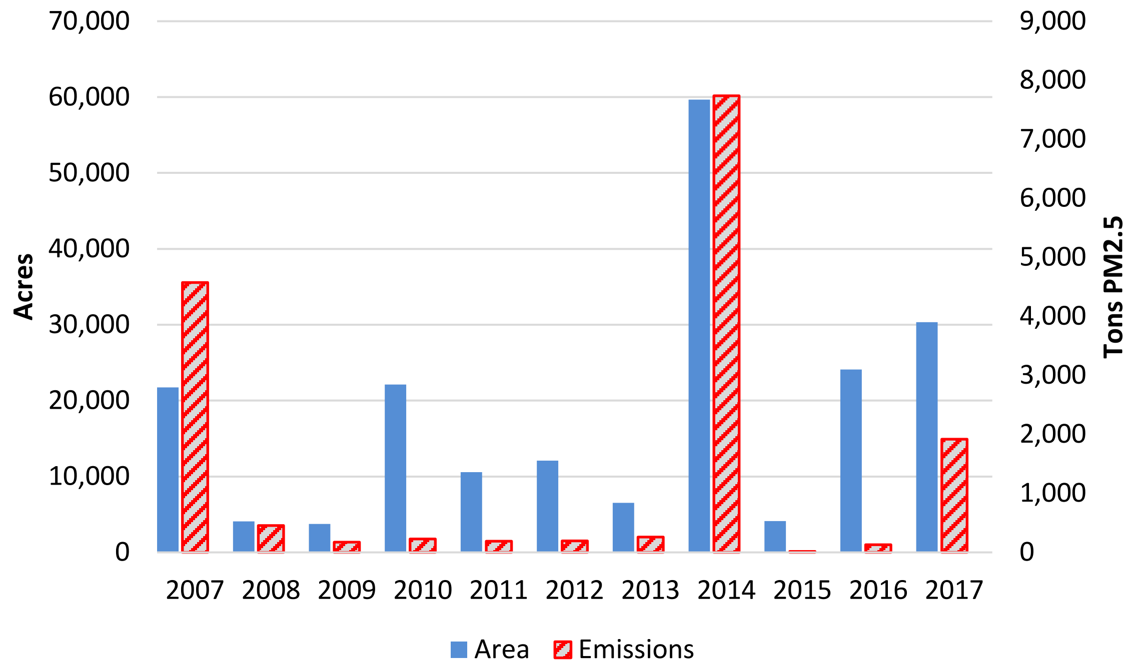

Figure 3 – Prescribed Area and Emissions from 2007 through 2017

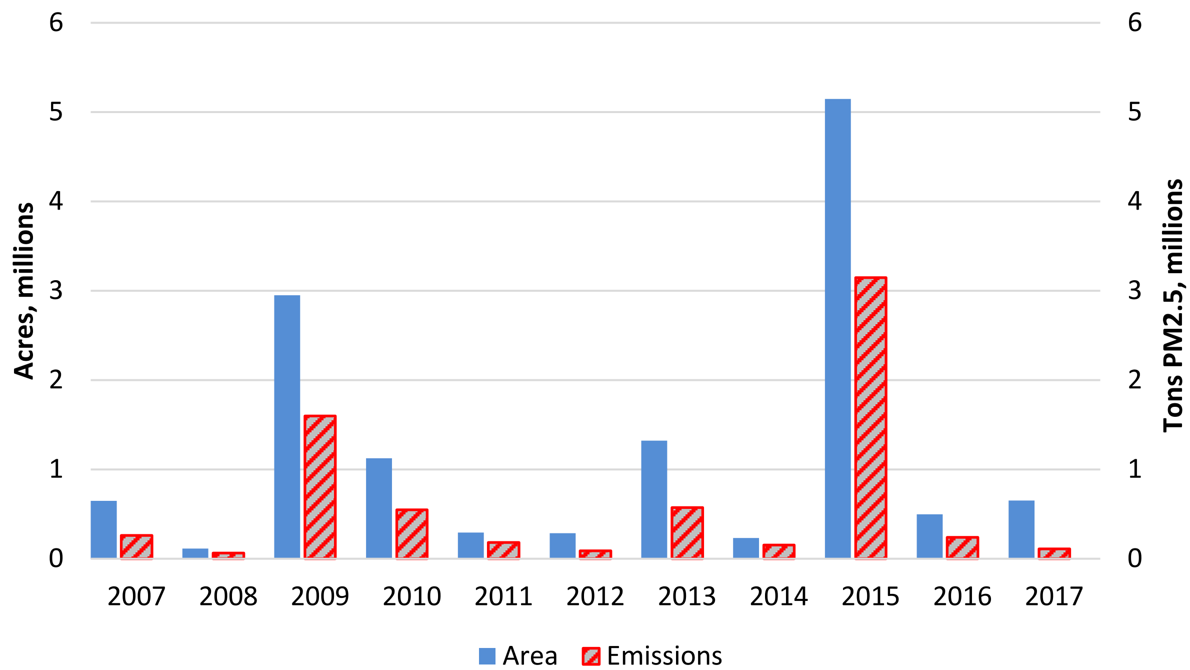

Figure 4 – Wildfire Area and Emissions 2007 through 2017

3.2 Temporal Emissions Distribution

Figure 5, shows the temporal distribution of emissions from both wildfires and prescribed fires. The majority of the prescribed fire emissions occurred in May and came from the 25,000 acre Oklahoma Impact Area fire. The Oklahoma fire was also the largest emission source, emitting 80% of all prescribed $PM_{2.5}$ emissions.

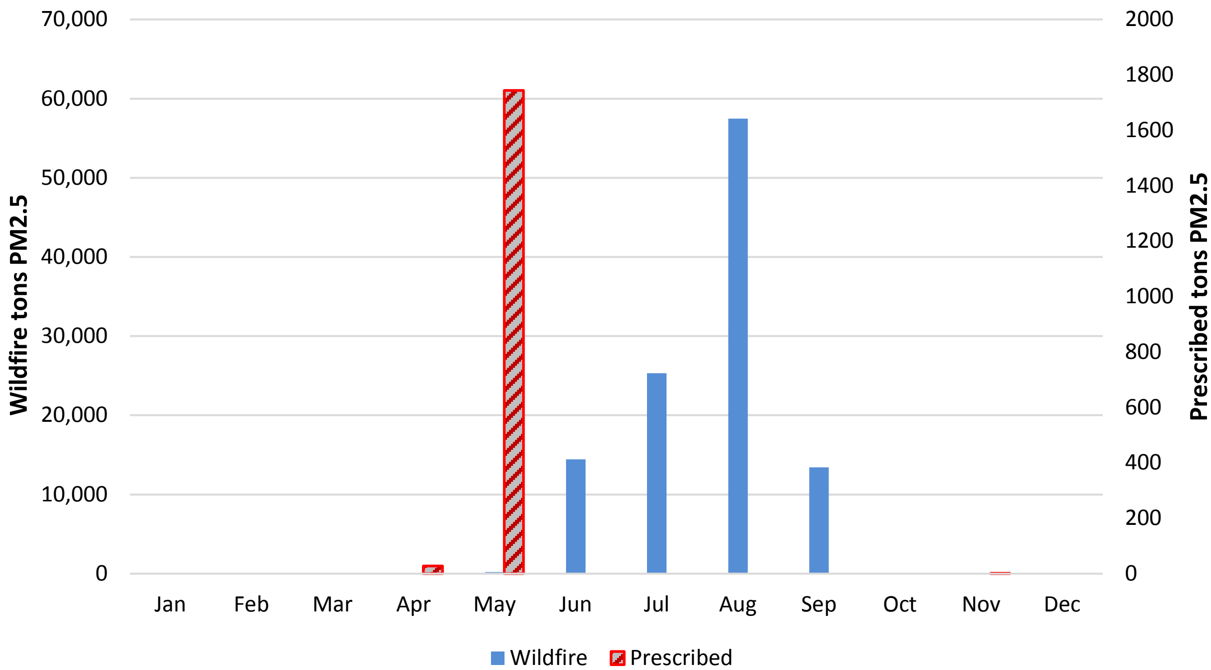

Figure 5 – Wildfire and Prescribed Fire Emissions Temporal Distribution

3.3 Emissions by Fire Cause

Historically, lightning ignites the majority of fires in Alaska. In 2017, lightning ignited 41% of wildfires, as opposed to human activity which started 56% of the wildfires. Fires ignited by lightning are more likely to start in remote areas, which commonly results in limited suppression response and limited ability to monitor. In 2017, 95% of $PM_{2.5}$ emissions came from fires started by lightning (Figure 6).

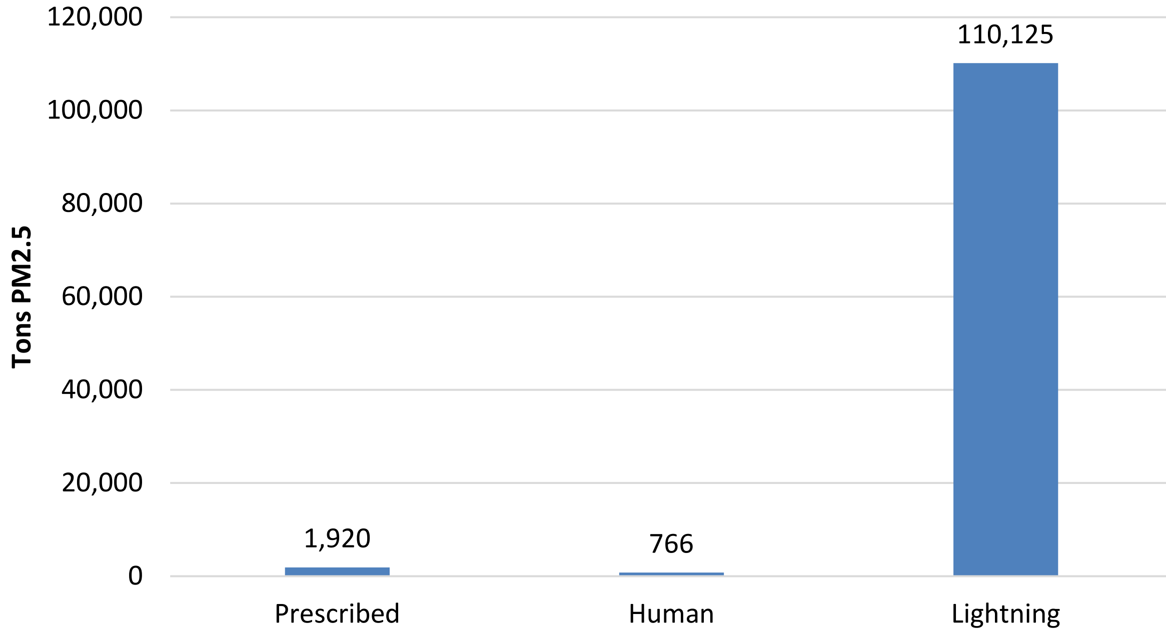

Figure 6 – $PM_{2.5}$ Emissions by Fire Cause

3.4 Emission Reduction Techniques

Emission Reduction Techniques (ERTs) reduce emissions from prescribed fires. Examples include using multiple ignition points, igniting under weather conditions that promote good plume rise, and ensuring that vegetation is dry.

In 2017, the application of ERTs reduced emission of $PM_{2.5}$ by 55% (Figure 7). In addition to reducing emissions, prescribed fires reduce fuel load and create firebreaks, thereby preventing larger uncontrolled fires from occurring.

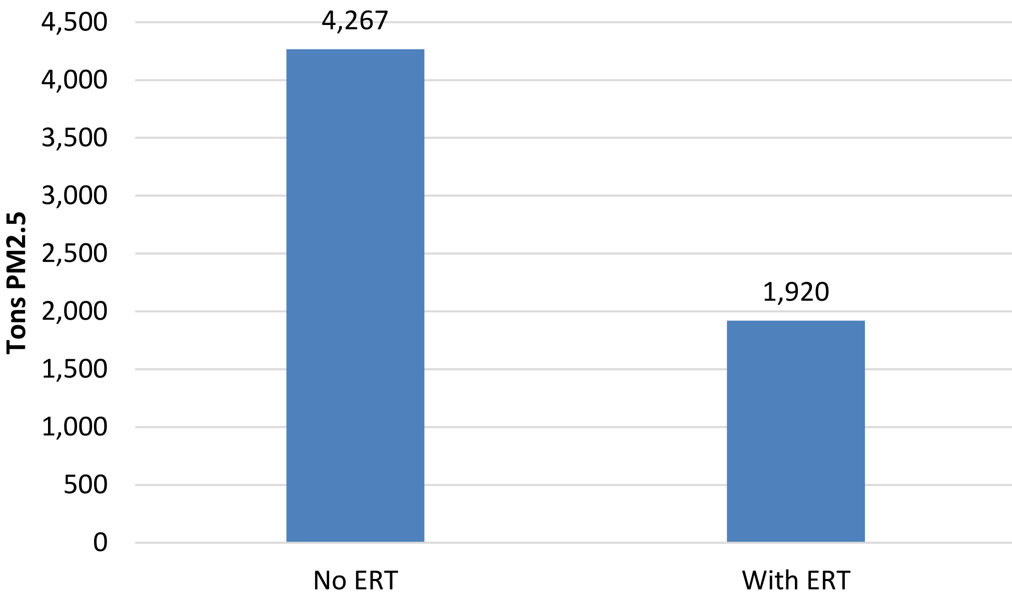

Figure 7 – $PM_{2.5}$ Emission Reductions from Emission Reduction Techniques (ERT)

3.5 <u>All Pollutants</u>

Table 4 and Figure 8 show the quantities of the pollutants inventoried for this report. Figure 8 does not display carbon monoxide because the quantity is so much greater than the other pollutants. Particulate matter, which reduces visibility and contributes to regional haze is of particular importance. $PM_{2.5}$ emitted from flaming comprised 86% of the particulate matter emitted from fires versus smoldering burns. All particulate matter has health effects at high levels but $PM_{2.5}$ is particularly noxious because of its small size and ability to penetrate deep into the lungs, causing respiratory complications and exacerbating bronchoconstriction.

Table 4 – Tons of Pollutants Emitted in 2017

Pollutant	Abbreviation	Tons Emitted
Fine particulate matter	$PM_{2.5}$	112,824
Coarse particulate matter	PM_{10}	112,824
Elemental carbon	EC	8,683
Organic carbon	OC	60,643
Sulfur dioxide	SO_2	23,975
Oxides of nitrogen	NO_X	87,438
Volatile organic compounds	VOC	88,849
Methane	CH_4	108,593
Ammonia	NH_3	7,051
Carbon monoxide	CO	1,047,849

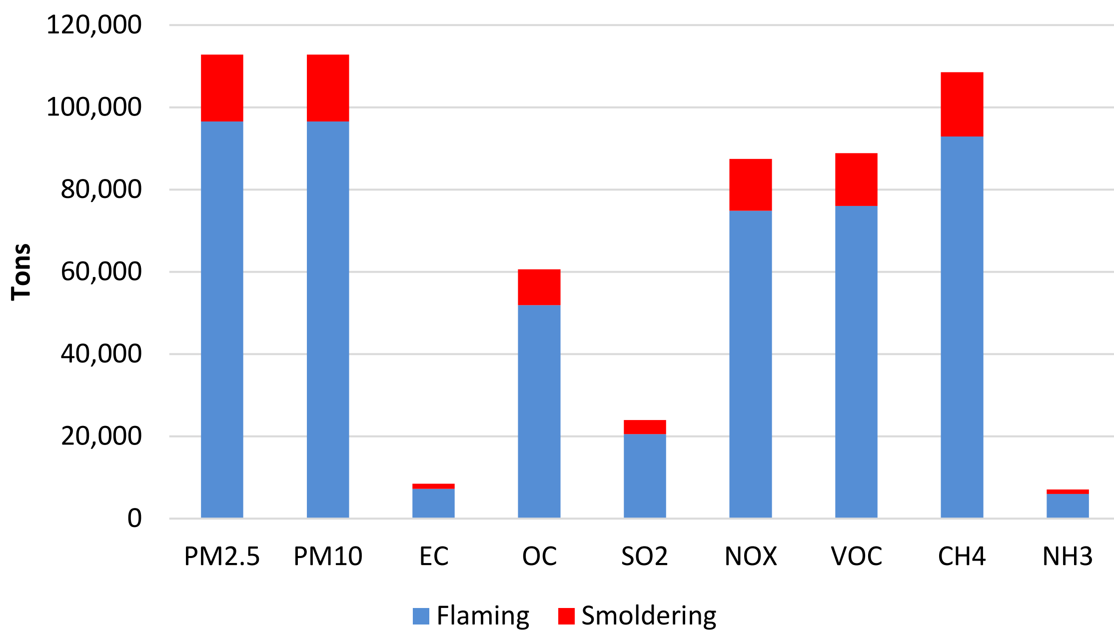

Figure 8 – Tonnage of Pollutants Emitted in 2017
* The tons of CO emitted is not included due to the scale of the graph.

4 AIR QUALITY STANDARDS AND EXCEEDANCES

EPA sets National Ambient Air Quality Standards (NAAQS) for six criteria pollutants to protect human health. As previously stated, $PM_{2.5}$ is the criteria pollutant of primary concern from wildland fires. An exceedance of the $PM_{2.5}$ NAAQS occurs when the 24-hour average concentration, measured in micrograms per cubic meter (µg/m^3), exceeds 35.4. In Alaska, DEC measures $PM_{2.5}$ in the major population areas and one or two remote locations that can vary from year to year.

Monitors recorded 20 exceedances from 2006 to 2017 caused by wildfire (Figure 9). There was one exceedance in 2017. Due to the irregularity of fire location and the availability of monitoring data, the number of exceedances does not strongly correlate with the intensity of a fire year.

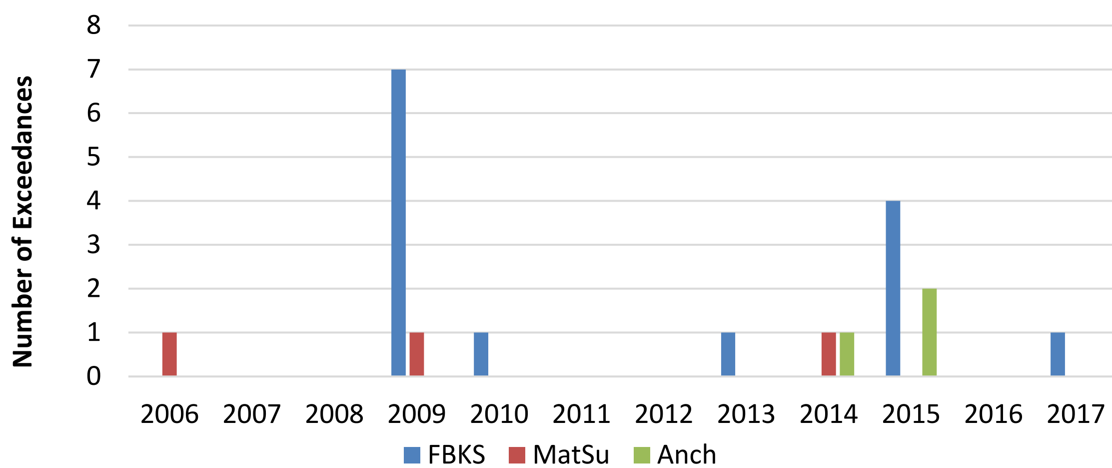

Figure 9 –Exceedances of Air Quality Standards by Area due to Wildfires

To address emissions from natural events DEC prepares exceptional event waiver requests for exceedances recorded as a result of fires. DEC posts exceptional event waiver requests on its website at: http://dec.alaska.gov/air/am/exceptional_events.htm. Exceptional events demonstrations ensure that states are not required to develop a SIP for uncontrollable sources of pollution. When EPA approves an exceptional event demonstration, the data is removed from modeling for programs such as regional haze and nonattainment or reclassifications determinations.

5 AIR QUALITY ADVISORIES

DEC issues air quality advisories during times of widespread elevated pollution levels, which typically result from wildland fire smoke, windblown dust, volcanic ash, or high levels of wintertime $PM_{2.5}$. Advisories use the Air Quality Index (AQI) to normalize air quality readings across multiple pollutants and issue corresponding cautionary statements (Table 5).

Table 5 – Air Quality Index Levels for $PM_{2.5}$

24-Hour $PM_{2.5}$ Level (µg/m^3)	AQI Score	AQI Category	AQI Cautionary Statement
0.0 to 12.0	0-50	Good	None
12.1 to 35.4	51-100	Moderate	Unusually sensitive people should consider reducing prolonged or heavy exertion.
35.5 to 55.4	101-150	Unhealthy for Sensitive Groups	People with respiratory or heart disease, the elderly, and children should limit prolonged exertion.
55.5 to 150.4	151-200	Unhealthy	People with respiratory or heart disease, the elderly, and children should avoid prolonged exertion; everyone else should limit prolonged exertion.
150.5 to 250.4	201-300	Very Unhealthy	People with respiratory or heart disease, the elderly, and children should avoid any outdoor activity; everyone else should avoid prolonged exertion.
> 250.5	301-500	Hazardous	Everyone should avoid any outdoor exertion; people with respiratory or heart disease, the elderly, and children should remain indoors.

The number of air quality advisories is not necessarily dependent on the acreage burned in a year. Factors such as fire location, duration, intensity, wind direction, and wind speed all play a role in fire behavior and issued air quality advisories (Figure 10). Large fire years are usually accompanied by an increased number of advisories.

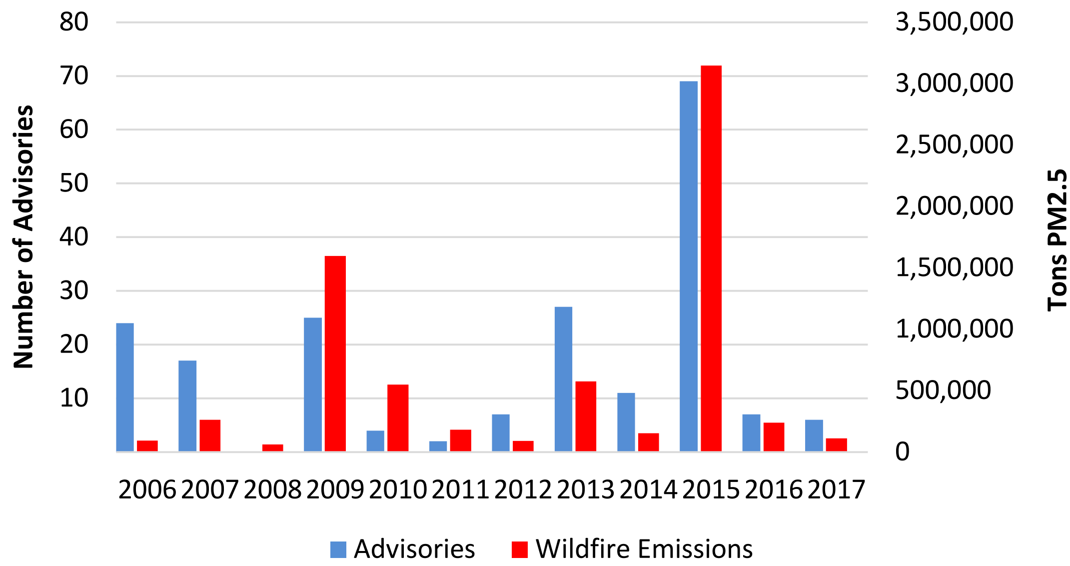

Figure 10 – Air Quality Advisories Issued due to Wildfire Emissions

Figure 11 shows the number of advisories issued by month on an annual basis due to fires. DEC issued six air quality advisories in 2017 covering a total of 28 days between June and July. Three advisories were issued in June and three were issued in July (Figure 11). Multiple air quality advisories may be issued on the same day for different areas of the State, and advisories span multiple days. All the advisories that DEC or local communities call may be found at:
http://dec.alaska.gov/Applications/Air/airtoolsweb/Advisories

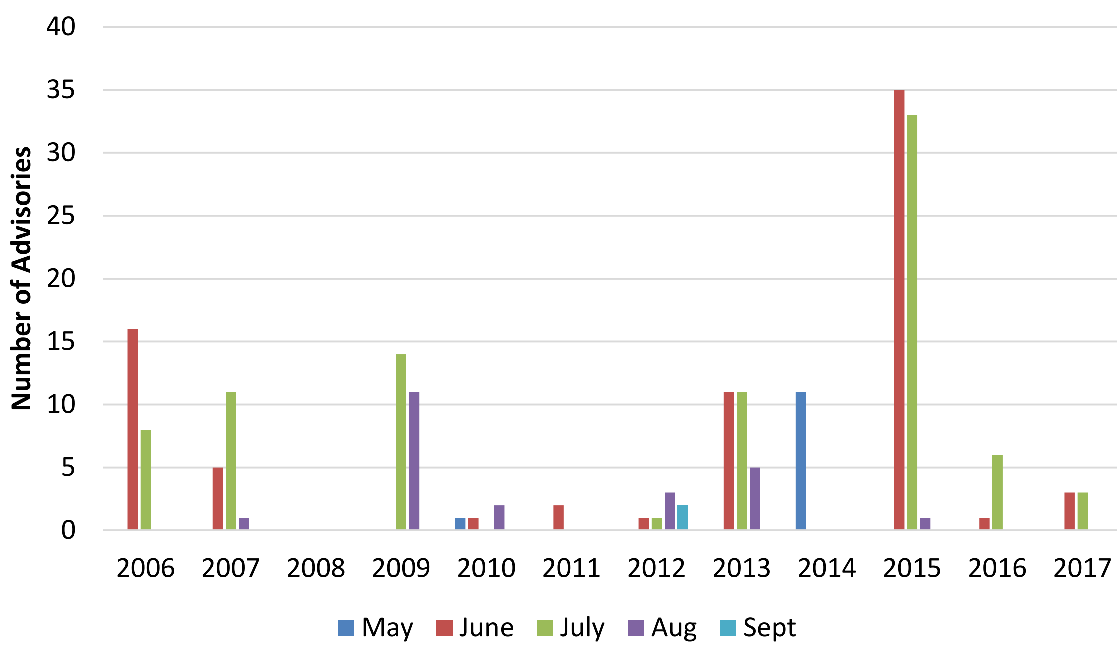

Figure 11 – Number of Air Quality Advisories Issued by Month

Appendix 1 – Vegetation Types and Fuel Factors

Table 1 provides the basic fuel factor name and factor values listed in tons per acre (tpa).

Table 1: Basic Fuel Factor Name and Fuel Factors

Fuel Factor Name	Fuel Factor – tpa
Western grasses (annual)	0.50
Western grasses (perennial)	0.75
Intermediate brush	15.00
Tundra	19.30
Short needle (normal dead)	27.54
Short needle (heavy dead)	43.50
Intermediate slash	33.95
Alaskan black spruce	57.57

Table 2 shows the calculations used to determine the 2017 LANDFIRE fuel factor for the 19 largest fires. As described in Section 2.2, LANDFIRE fuel factors are an average of two Basic Method fuel factors.

$$\frac{\text{Fuel Factor Name 1 value} \times \text{Fuel Factor Name 2 value}}{2} = \text{LANDFIRE Fuel Factor - tpa}$$

Table 2: LANDFIRE Vegetation Types and Fuel Factors

Vegetation Type Name	Fuel Factor Name 1	Fuel Factor Name 2	Fuel Factor -tpa
Barren	None	None	0.00
Boreal Sparsely Vegetated	None	None	0.00
Open Water	None	None	0.00
Snow-Ice	None	None	0.00
Agriculture-Cultivated Crops and Irrigated Agriculture	Western grasses (perennial)	Western grasses (perennial)	0.75
Alaska Arctic Mesic Herbaceous Meadow	Western grasses (perennial)	Western grasses (perennial)	0.75
Alaska Sub-boreal and Maritime Alpine Mesic Herbaceous Meadow	Western grasses (perennial)	Western grasses (perennial)	0.75
Arctic Herbaceous Wetlands	Western grasses (perennial)	Western grasses (perennial)	0.75
Arctic Sedge Meadows	Western grasses (perennial)	Western grasses (perennial)	0.75

Vegetation Type Name	Fuel Factor Name 1	Fuel Factor Name 2	Fuel Factor -tpa
Boreal Aquatic Beds	Western grasses (perennial)	Western grasses (perennial)	0.75
Boreal Herbaceous Wetlands	Western grasses (perennial)	Western grasses (perennial)	0.75
Developed-Low Intensity	Western grasses (perennial)	Western grasses (perennial)	0.75
Developed-Open Space	Western grasses (perennial)	Western grasses (perennial)	0.75
Western North American Boreal Alpine Mesic Herbaceous Meadow	Western grasses (perennial)	Western grasses (perennial)	0.75
Western North American Boreal Dry Grassland	Western grasses (perennial)	Western grasses (perennial)	0.75
Western North American Sub-boreal Mesic Bluejoint Meadow	Western grasses (perennial)	Western grasses (perennial)	0.75
Alaska Arctic Dwarf-Shrubland	Intermediate brush	Western grasses (perennial)	7.88
Alaska Arctic Scrub Birch-Ericaceous Shrubland	Intermediate brush	Western grasses (perennial)	7.88
Alaska Sub-boreal Avalanche Slope Shrubland	Intermediate brush	Western grasses (perennial)	7.88
Alaska Sub-boreal Mesic Subalpine Alder Shrubland	Intermediate brush	Western grasses (perennial)	7.88
Alaskan Pacific Maritime Alpine Dwarf-Shrubland	Intermediate brush	Western grasses (perennial)	7.88
Alaskan Pacific Maritime Subalpine Alder-Salmonberry Shrubland	Intermediate brush	Western grasses (perennial)	7.88
Boreal Dwarf Shrub Wetland	Intermediate brush	Western grasses (perennial)	7.88
Boreal Floodplains	Intermediate brush	Western grasses (perennial)	7.88
Boreal Herbaceous Floodplains	Intermediate brush	Western grasses (perennial)	7.88
Boreal Peatlands	Western grasses (perennial)	Intermediate brush	7.88
Boreal Shrub Floodplains	Intermediate brush	Western grasses (perennial)	7.88
Boreal Shrub Swamp	Intermediate brush	Western grasses (perennial)	7.88
Pacific Maritime Herbaceous Wetlands	Western grasses (perennial)	Intermediate brush	7.88
Pacific Maritime Shrub Floodplains	Western grasses (perennial)	Intermediate brush	7.88

Vegetation Type Name	**Fuel Factor Name 1**	**Fuel Factor Name 2**	**Fuel Factor -tpa**
Western North American Boreal Alpine Dryas Dwarf-Shrubland	Intermediate brush	Western grasses (perennial)	7.88
Western North American Boreal Alpine Dwarf-Shrub Summit	Intermediate brush	Western grasses (perennial)	7.88
Western North American Boreal Alpine Dwarf-Shrub-Lichen Shrubland	Intermediate brush	Western grasses (perennial)	7.88
Western North American Boreal Alpine Ericaceous Dwarf-Shrubland	Intermediate brush	Western grasses (perennial)	7.88
Boreal Riparian Stringer Forest and Shrubland	Intermediate brush	Intermediate brush	15.00
Arctic Peatlands	Tundra	Intermediate brush	17.15
Alaska Arctic Acidic Dwarf-Shrub Lichen Tundra	Tundra	Tundra	19.30
Arctic Floodplains	Tundra	Tundra	19.30
Arctic Shrub-Tussock Tundra	Tundra	Tundra	19.30
Boreal Shrub-Tussock Tundra	Tundra	Tundra	19.30
Boreal Tussock Tundra	Tundra	Tundra	19.30
Western North American Boreal Spruce-Lichen Woodland	Short needle (heavy dead)	Western grasses (perennial)	22.13
Boreal Coniferous Woody Wetland	Alaskan black spruce	Western grasses (perennial)	29.16
Western North American Boreal Mesic Scrub Birch-Willow Shrubland	Short needle (heavy dead)	Intermediate brush	29.25
Western North American Boreal Subalpine Balsam Poplar-Aspen Woodland	Short needle (heavy dead)	Intermediate brush	29.25
Boreal Forested Floodplains	Alaskan black spruce	Intermediate brush	36.29
Boreal Forest-Tussock Tundra	Alaskan black spruce	Tundra	38.44
Recently Burned-Tree Cover	Short needle (heavy dead)	Short needle (heavy dead)	43.50
Western North American Boreal Dry Aspen-Steppe Bluff	Short needle (heavy dead)	Short needle (heavy dead)	43.50
Western North American Boreal Mesic Birch-Aspen Forest	Short needle (heavy dead)	Short needle (heavy dead)	43.50
Alaska Boreal Hardwood Forest	Alaskan black spruce	Alaskan black spruce	57.57

Vegetation Type Name	**Fuel Factor Name 1**	**Fuel Factor Name 2**	**Fuel Factor -tpa**
Alaska Boreal White Spruce Forest	Alaskan black spruce	Alaskan black spruce	57.57
Alaska Boreal White Spruce-Hardwood Forest	Alaskan black spruce	Alaskan black spruce	57.57
Alaska Sub-boreal Hardwood Forest	Alaskan black spruce	Alaskan black spruce	57.57
Alaska Sub-boreal Mountain Hemlock-White Spruce Forest	Alaskan black spruce	Alaskan black spruce	57.57
Alaska Sub-boreal White Spruce Forest	Alaskan black spruce	Alaskan black spruce	57.57
Alaska Sub-boreal White Spruce-Hardwood Forest	Alaskan black spruce	Alaskan black spruce	57.57
Alaska Sub-boreal White-Lutz Spruce Forest and Woodland	Alaskan black spruce	Alaskan black spruce	57.57
Alaskan Pacific Maritime Mountain Hemlock Forest	Alaskan black spruce	Alaskan black spruce	57.57
Boreal Black Spruce-Tussock Woodland	Alaskan black spruce	Alaskan black spruce	57.57
Boreal Coniferous-Deciduous Woody Wetland	Alaskan black spruce	Alaskan black spruce	57.57
Western North American Sub-boreal Mesic Bluejoint Meadow	Alaskan black spruce	Alaskan black spruce	57.57
Western North American Boreal Mesic Black Spruce Forest	Alaskan black spruce	Alaskan black spruce	57.57
Western North American Boreal Treeline White Spruce Woodland	Alaskan black spruce	Alaskan black spruce	57.57
Western North American Boreal White Spruce Forest	Alaskan black spruce	Alaskan black spruce	57.57
Western North American Boreal White Spruce-Hardwood Forest	Alaskan black spruce	Alaskan black spruce	57.57

Table 3: 2016 LANDFIRE Factor Contributions - 19 Largest Fires

Factor Contribution	Fuel Factor	% Veg Type	Vegetation Type Name
10.70006	57.57	18.59%	Western North American Boreal White Spruce Forest
0.43337	57.57	0.75%	Western North American Boreal Treeline White Spruce Woodland
0.54261	22.125	2.45%	Western North American Boreal Spruce-Lichen Woodland
1.40803	57.57	2.45%	Alaska Boreal White Spruce Forest
10.64844	57.57	18.50%	Western North American Boreal Mesic Black Spruce Forest
3.71216	43.5	8.53%	Western North American Boreal Mesic Birch-Aspen Forest
0.06299	43.5	0.14%	Western North American Boreal Dry Aspen-Steppe Bluff
0.00081	29.25	0.00%	Western North American Boreal Subalpine Balsam Poplar-Aspen Woodland
0.00702	7.875	0.09%	Alaska Sub-boreal Avalanche Slope Shrubland
0.00925	7.875	0.12%	Alaska Sub-boreal Mesic Subalpine Alder Shrubland
2.35188	29.25	8.04%	Western North American Boreal Mesic Scrub Birch-Willow Shrubland
0.00832	0.75	1.11%	Western North American Sub-boreal Mesic Bluejoint Meadow
0.01158	0.75	1.54%	Western North American Boreal Dry Grassland
0.00338	7.875	0.04%	Western North American Boreal Alpine Dwarf-Shrub Summit
0.00777	7.875	0.10%	Western North American Boreal Alpine Dryas Dwarf-Shrubland
0.01358	7.875	0.17%	Western North American Boreal Alpine Ericaceous Dwarf-Shrubland
0.06778	7.875	0.86%	Western North American Boreal Alpine Dwarf-Shrub-Lichen Shrubland
0.00528	7.875	0.07%	Alaska Arctic Mesic Alder Shrubland
0.01805	7.875	0.23%	Alaska Arctic Mesic-Wet Willow Shrubland
0.08276	57.57	0.14%	Alaska Sub-boreal White-Lutz Spruce Forest and Woodland
0.12488	57.57	0.22%	Alaska Sub-boreal White Spruce-Hardwood Forest
0.37712	7.875	4.79%	Alaska Arctic Scrub Birch-Ericaceous Shrubland
0.00184	0.75	0.25%	Alaska Arctic Mesic Sedge-Willow Tundra
0.00000	0.75	0.00%	Alaska Arctic Mesic Sedge-Dryas Tundra
0.00001	19.3	0.00%	Alaska Arctic Acidic Sparse Tundra
0.00000	0.75	0.00%	Alaska Arctic Non-Acidic Sparse Tundra
0.00000	7.875	0.00%	Alaska Arctic Lichen Tundra
0.00021	0.75	0.03%	Alaska Arctic Acidic Dryas Dwarf-Shrubland
0.00000	0.75	0.00%	Alaska Arctic Non-Acidic Dryas Dwarf-Shrubland
0.00103	7.875	0.01%	Alaska Arctic Dwarf-Shrubland

Factor Contribution	Fuel Factor	% Veg Type	Vegetation Type Name
0.00197	19.3	0.01%	Alaska Arctic Acidic Dwarf-Shrub Lichen Tundra
0.00002	0.75	0.00%	Alaska Arctic Non-Acidic Dwarf-Shrub Lichen Tundra
0.00000	0.75	0.00%	Alaska Arctic Mesic Herbaceous Meadow
0.00000	0	0.35%	Barren
0.00000	0	0.00%	Snow-Ice
0.00000	0	0.38%	Open Water
0.00013	0.75	0.02%	Boreal Aquatic Beds
0.00004	7.875	0.00%	Polar Tidal Marshes and Aquatic Beds
0.00004	0.75	0.01%	Arctic Herbaceous Wetlands
0.00538	0.75	0.72%	Boreal Herbaceous Wetlands
0.00042	0.75	0.06%	Arctic Sedge Meadows
0.01846	57.57	0.03%	Alaska Sub-boreal White Spruce-Hardwood Forest
2.20700	29.16	7.57%	Boreal Coniferous Woody Wetland
0.90131	57.57	1.57%	Boreal Coniferous-Deciduous Woody Wetland
0.00712	7.875	0.09%	Boreal Dwarf Shrub Wetland
0.00005	7.875	0.00%	Recently Burned-Herb and Grass Cover
0.00080	19.3	0.00%	Arctic Floodplains
0.27830	7.875	3.53%	Boreal Floodplains
0.36999	19.3	1.92%	Boreal Shrub-Tussock Tundra
0.00001	0.75	0.00%	Developed-Low Intensity
0.00431	17.15	0.03%	Arctic Peatlands
0.14944	7.875	1.90%	Boreal Peatlands
0.00298	15	0.02%	Boreal Riparian Stringer Forest and Shrubland
0.04157	7.875	0.53%	Boreal Shrub Swamp
0.53237	57.57	0.92%	Western North American Boreal White Spruce-Hardwood Forest
0.00430	0.75	0.57%	Western North American Boreal White Spruce-Hardwood Forest
0.01028	19.3	0.05%	Arctic Sedge-Tussock-Lichen Tundra
0.09889	19.3	0.51%	Boreal Tussock Tundra
0.00017	19.3	0.00%	Arctic Tussock Tundra
0.28187	19.3	1.46%	Arctic Shrub-Tussock Tundra
0.00000	0.75	0.00%	Arctic Shrub Tundra
1.39984	19.3	7.25%	Boreal Shrub-Tussock Tundra
0.04142	7.875	0.53%	Boreal Floodplains
0.04340	7.875	0.55%	Boreal Floodplains
0.01256	57.57	0.02%	Alaska Sub-boreal White Spruce-Hardwood Forest
0.00006	19.3	0.00%	Arctic Sparsely Vegetated
0.00000	0	0.17%	Boreal Sparsely Vegetated
0.00000	0.75	0.00%	Arctic Sedge-Tussock-Lichen Tundra
100%	**37.01**	**Final Fuel Factor (composite)**	