2015 Alaska Wildfire Emissions Inventory

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

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1 INTRODUCTION

The Alaska Department of Environmental Conservation (DEC), in coordination with the Alaska Wildfire Coordinating Group (AWFCG), developed the Alaska Enhanced Smoke Management Plan (ESMP) to reduce smoke impacts from prescribed burning in Alaska. The current ESMP and accompanying volume of appendices were adopted by the AWFCG in June 2015. According to the ESMP, DEC is responsible for collecting, reviewing, tracking, and summarizing burn data for annual ESMP emissions inventory reports to be distributed to the AWFCG, the US Environmental Protection Agency, and the Western Regional Air Partnership (WRAP).

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

This report fulfils the responsibility for reporting 2015 prescribe fire emissions as required by the ESMP. It provides information about the DEC Open Burn Applications for prescribed or land clearing burns received and approved by DEC for 2015 and it reports statewide wildfire emissions for the same year.

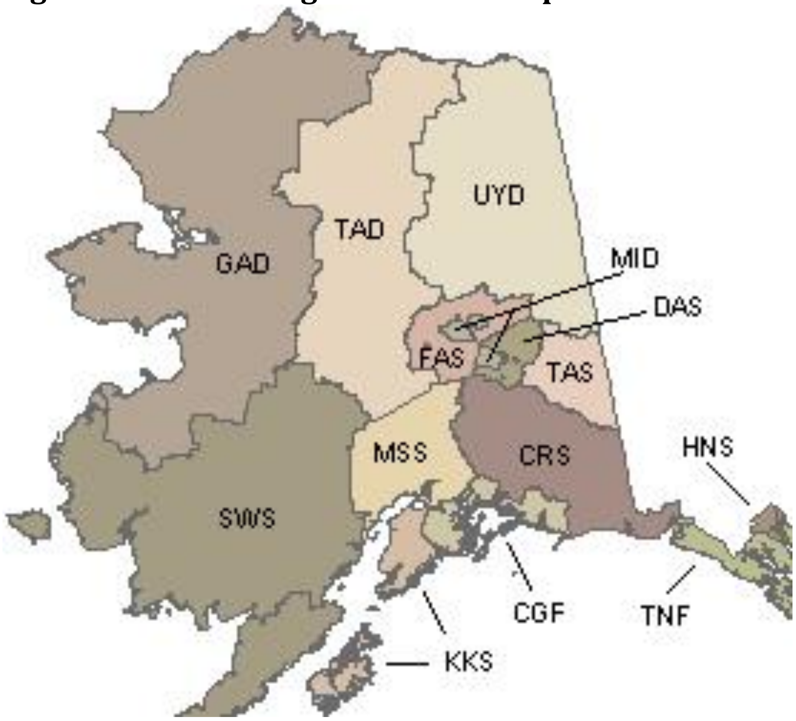
1.1 Fire Management in Alaska

The Alaska Interagency Coordination Center (AICC) is the Geographic Area Coordination Center for Alaska. Located on Fort Wainwright, near Fairbanks, the AICC serves at 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, State of Alaska Department of Natural Resource's Division of Forestry, USDA Forest Service, National Park Service, Bureau of Indian Affairs, and the US Fish and Wildlife Service. AICC collects wildfire data and prepares daily situation reports. DEC also receives burn applications from any person or organization which intends to burn or pile and burn more than 40 acres per year.

Fire management planning, preparedness, suppression, prescribed fire, and related activities are coordinated on an interagency basis through the AICC and AWFCG. For the purposes of fire suppression, the Bureau of Land Management, the Forest Service, and state Division of Forestry each take responsibility for managing fire in agreed upon 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 and promotes efficient and cost effective use of facilities and resources to manage fires.

Figure 1 – Fire Management Zone Map



- Chugach National Forest (CGF)
- Valdez/Copper River Area Forestry (CRS)
- Delta Area Forestry (DAS)
- Fairbanks Area Forestry (FAS)
- Galena Fire Management Zone (GAD)
- Haines/Northern Southeast Area Forestry (HNS)
- Kenai-Kodiak Area Forestry (KKS)
- Military Fire Management Zone (MID/MIL)
- Mat-Su/Southwest Area Forestry (MSS)
- Southwest District Forestry (SWS)
- Tanana Fire Management Zone (TAD)
- Tok Area Forestry (TAS)
- Tongass National Forest (TNF)
- Upper Yukon Fire Management Zone (UYD)

1.2 Fire and Air Quality

A flip of the old adage tells us that where there's fire, there's smoke. Because of the smoke from wildland fires, DEC's Air Quality Division tracks wildfires and regulates prescribed fires.

Smoke is made up of a wide range of chemical compounds, including all of the criteria pollutants regulated by the US Environmental Protection Agency (EPA). Smoke also impairs visibility: local impairment can be severe and contribute to unsafe driving conditions and regional impairment contributes to haze and obscures vistas. The pollutants inventoried for this report are listed in Table 1; along with the reasons for including the pollutants.

Table 1 – Pollutants Inventoried

Pollutant	Abbreviation	Reason for tracking
Fine particulate matter	PM2.5	Criteria pollutant
Coarse particulate matter	PM10	Criteria pollutant
Elemental carbon	EC	Visibility impairment
Organic carbon	OC	Visibility impairment
Sulfur dioxide	SO2	Criteria pollutant
Oxides of nitrogen	NOX	Criteria pollutant
Volatile organic compounds	VOC	Hazardous air pollutant
Methane	CH4	Hazardous air pollutant
Ammonia	NH3	Visibility impairment
Carbon monoxide	CO	Criteria pollutant

This report focuses on fine particulate matter, also called PM2.5, because it is the primary pollutant of concern from wildland fires. Fine particulate matter comprises all airborne particles with a diameter smaller than 2.5 microns. Because PM2.5 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. And, because the particles are so small, they can be inhaled deeply into the lungs, causing cardiovascular and respiratory health risks.

1.3 Open Burn Approvals

Because of the health and visibility effects of smoke, DEC requires anyone burning, or clearing and burning, over 40 acres in one year to obtain an air quality approval before burning. 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 those conducting burns to work with the DEC meteorologist and to submit post burn reports that allow DEC to track and inventory pollutants.

During 2015, DEC granted 5 approvals for open burns for land clearing and 32 approvals for training. Resource agencies submitted post burn reports for 11 prescribed fires. AICC reported three open burns that were less than 40 acres and did not require a permit from DEC. These burns did not submit a post burn report; however, they are included in the inventory calculations.

There were no known adverse effects to Sensitive Areas or to Class I Areas.

2 METHOD

To prepare the 2015 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 based on vegetation type. 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.

For the 2015 inventory, as in previous inventories, 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 below.

2.1 <u>Basic Method</u>

For most of the fires, DEC assigned a fuel loading factor based on the vegetation type listed in the AICC dataset. Some fires did not have a vegetation type assigned in the data set. For these fires, where available, the vegetation type listed in the situation report was used. Otherwise, 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 that vegetation.

Table 2 – Fuel Loading Factors

Fuel Factor Name	Wildfire (tons per acre)	Prescribed (tons per acre)
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

Because fires can start in one vegetation type, and burn through others, for the largest fires, AICC provided more detailed vegetation data from the LANDFIRE system. This is the fourth year this approach has been used for the largest fires; the five largest are shown in Table 3. 2015 had 771 wildfires, the most in any recorded wildfire season, and the second highest total acres burned with 5,146,541 acres.

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 and assigns each zone a vegetation type and its corresponding fuel factor. Once the fractional areas are found (as defined as the zones area divided by the total fire area) they are multiplied by the corresponding fuel factor, listed in Appendix 1, and to find the fuel contribution. Once all the fuel contributions are found they are summed for a total fuel contribution. This summed value corresponds with the total fires representative fuel factor which is multiplied by the original fire acreage to give the total tons of vegetation that burn. This total tons then can have an emission factor applied to it. An example of this calculation from the Isahultila fire is included in Appendix 1. The process that results in the final fuel factor is the advantage of the LANDFIRE method over the Basic Method. While this method is much more time intensive, it can be beneficial when dealing with the largest fires.

LANDFIRE fuel factors can be an 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 (.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 1.

The LANDFIRE fuel factors are especially helpful for fires that burn in a variety of fuels because the fuel factor more accurately represents the true fuels present on the landscape instead of a blanket designation across the entire fire. Using the LANDFIRE calculated fuel factors for the largest fires, Table 3, reduced calculated emissions by 226,463 tons of PM2.5; compared to what would have reported under the Basic Method.

Table 3 – 2015 Largest Fires

Fire Name	Acres	LANDFIRE Fuel Factor	Basic Method Fuel Factor
Big Creek Two	312,918.2	34.97	57.57
Sushgitit Hills	276,038.2	40.07	57.57
Holtnakatna	223,154.1	31.54	27.54
Isahultila	149,359.3	42.86	57.57
Rock	142,650.4	37.55	57.57
Sum:	1,104,120	(21.45 % of 2015 acres)	

LANDFIRE fuel factors can differ considerably from the Basic fuel factor. LANDFIRE fuel factor is generally lower than the Basic Method. This has some advantages and disadvantages. In 2015, of the largest 5 fires, the only fire that reported to have a lower fuel factor using the Basic Method was the Holtnakatna fire. Initially the Holtnakatna fire was reported to be burning in mixed trees, consisting of both hard and softwoods, and under the Basic Method was listed with a fuel factor corresponding with that type of vegetation (27.54 tons/acre). Using the LANDFIRE method, the area was broken down more accurately and showed that a higher percentage of the fire was in hardwoods and is reflected in the higher LANDFIRE fuel factor. 78.4 percent of the Holtnakatna wildfire was at or above the Basic Method fuel factor.

2.3 Temporal Adjustments

The Wildland Fire Emission Template assigns emissions to certain months based on a fire's start and end dates, which may produce misleading results. The template averages the calendar start and end dates then assigns the emissions to the month of the averaged date. Sometimes this does not accurately reflect the time period a fire actually produced the most emissions because fires may not be declared out until long after the majority of the active combustion occurred. Temporal adjustments shift the fire to the time period that better reflect actual emission patterns. During 2015, there were no fires that needed to be recalculated in such a way and it is assumed that the average of the start and out dates was accurate enough for the purposes of this report.

2.4 Prescribed Fires

Two sources provide information on prescribed fires: the AICC data set and post burn reports submitted to DEC by organizations that conduct burns. The AICC dataset showed 8 prescribed burns over 40 acres and two burns under 40 acres totaling 4,120 acres. During 2015, DEC received 5 post burn reports from land clearing burns. Of these reports, most were already included in the AICC database, however the Mary Lake fire (12 acres) hadn't been reported to AICC but had a post burn report submitted to DEC. The Mary Lake fire was added to the AICC database making the final area burnt from prescribed fires 4,132 acres.

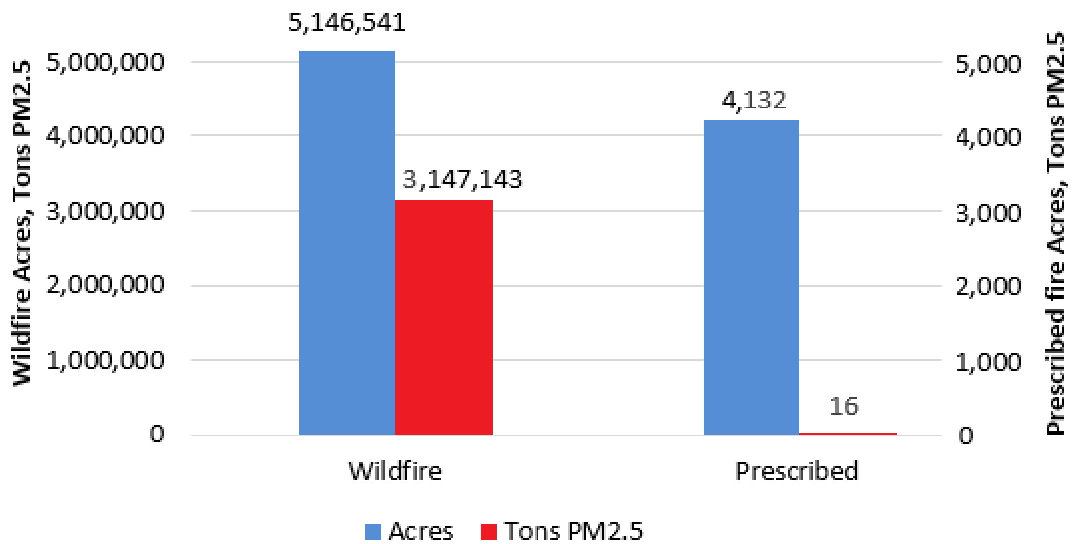
3 EMISSIONS

The following sections report the 2015 Alaska wildland fire emissions.

3.1 Total Acres and Emissions

During 2015, wild and prescribed fires burned a combined 5,150,673 acres. This remarkable increase over the previous five year can be attributed to a relatively small snow pack, a dry spring, and other climactic conditions that proliferated fires. The particulate emissions and area burnt are shown in Figure 2 for both wildfire and prescribed fires. Wildfires overwhelmingly dominated both the acres burnt, and tons PM2.5 emitted.

Figure 2 – Wild and Prescribed Area Burned and PM2.5 Emissions Released



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

- Prescribed fires are intentionally carried out under controlled conditions to produce fewer emissions.
- This year's prescribed fires were largely grass fires, which produce substantially fewer emissions than fires that have higher fuel loads. Of the 12 prescribed fires only two burnt in timber, totaling 17.7 acres.

Figures 3 and 4 compare prescribed and wildfire emissions to the area burned over the last decade. Both categories of fire can vary widely from year to year. For prescribed fires, this variation depends on need and the agencies' ability to accomplish the fires. Having the right weather conditions plays an important role in agencies' decisions to burn. Because of the dry weather and the fire activity that was already active on the landscape, 2015 was a small prescribed fire year with only 12 prescribed burns. 2015 was the second largest recorded fire year for wildfires, behind 2004.

The area burned each year by wildfire varies even more than the area burned by prescribed fires, historically ranging from under 10,000 acres to several million. With 5,150,673 acres, 2015 was a one of the highest years on record with 3,147,143 pounds of PM2.5 emitted. A drier than normal summer in the interior, where most wildfire activity in Alaska occurs, along with more lightning strikes than normal, produced a large number of fires that grew quickly.

Figure 3 – Prescribed Area and Emissions 2006 through 2015

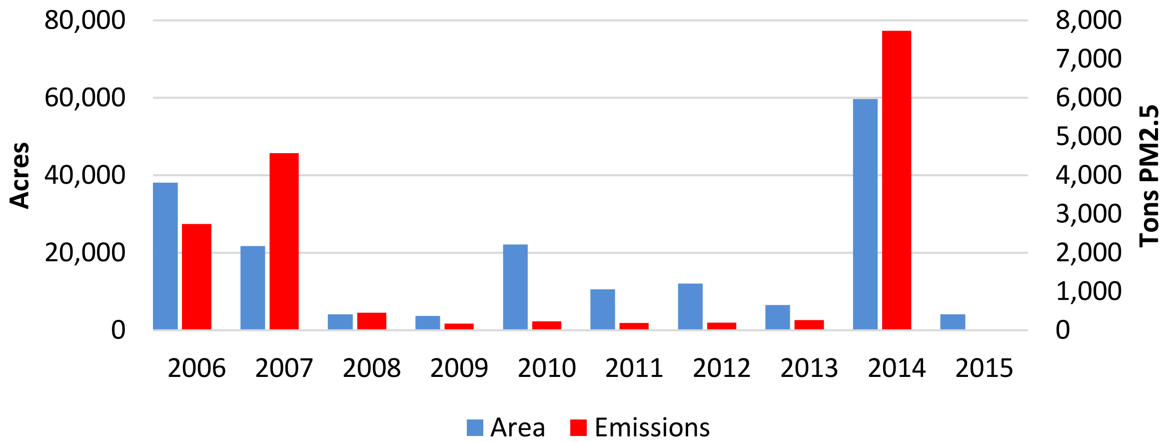
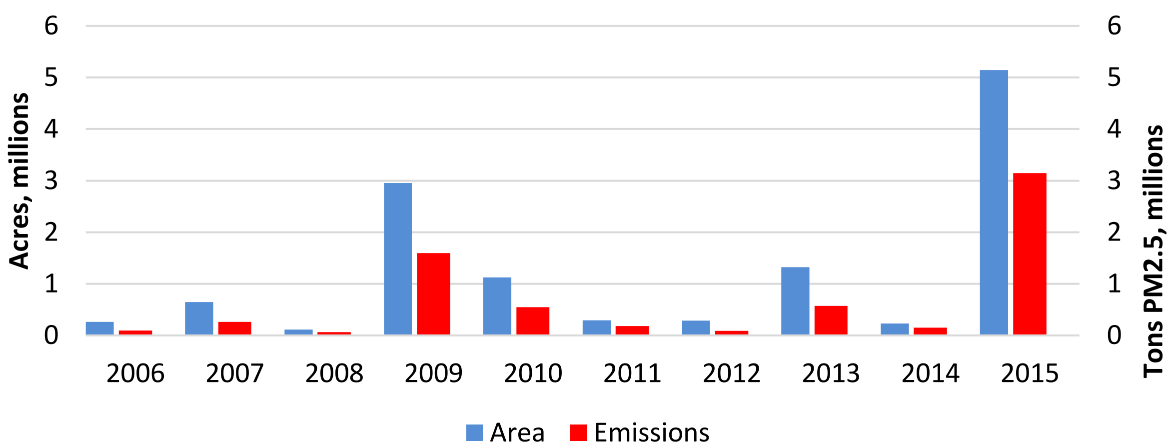


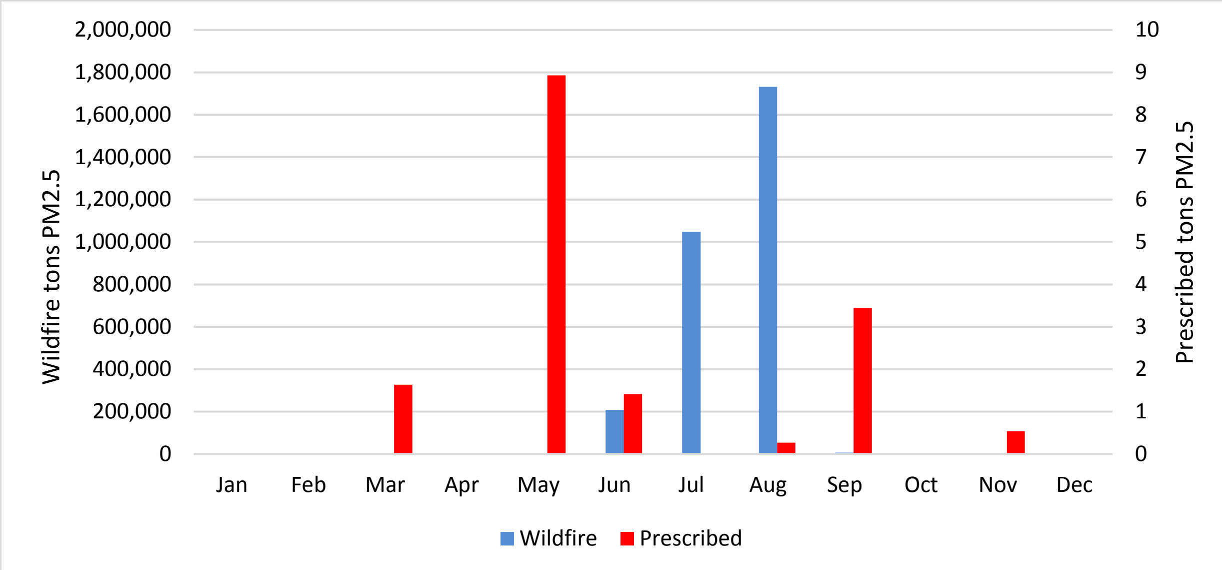
Figure 4 – Wildfire Area and Emissions 2006 through 2015



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 emission occurred in May and came from the 1,828 acre FWA Small Arms Complex. The FWA Small Arms Complex was also the primary emission source emitting 31% of all prescribed emissions.

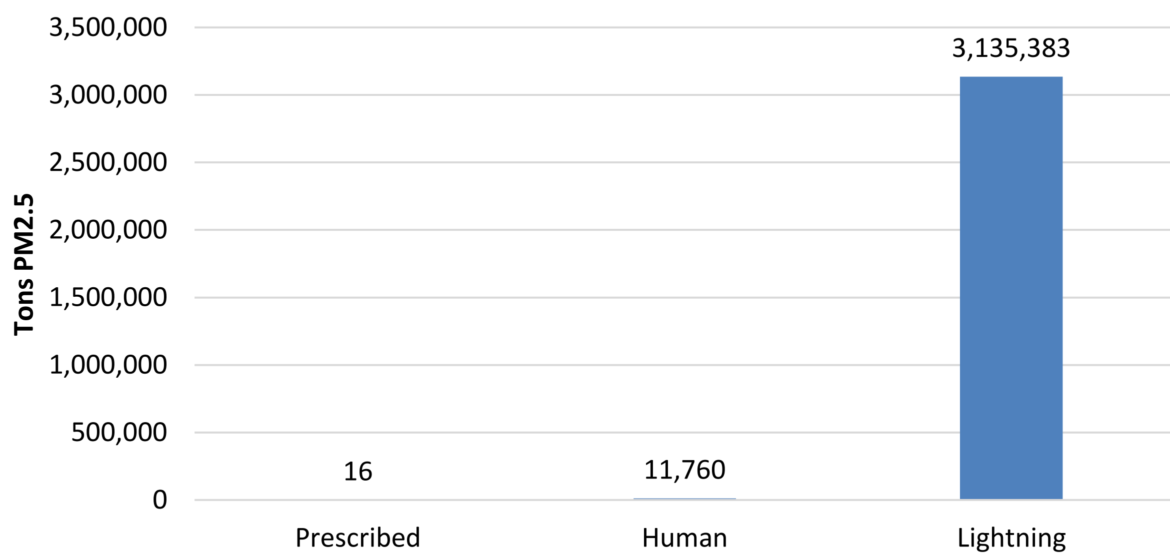
Figure 5 – Wildfire and Prescribed Fire Emissions Temporal Distribution



3.3 Emissions by Fire Cause

Historically, most fires in Alaska are ignited by lightning. In 2015, 54%, of fires were ignited by lightning as oppose to human activities. Over the week of June 19 to June 25, over 61,000 lightning strikes caused 295 wildfires. Fires ignited by lightning are more likely to start in remote areas and are commonly put in a limited response or just monitored instead of actively suppressing the fire. Because of this, nearly all emissions, 99.7%, came from fires started from lightning, as shown in Figure 6.

Figure 6 – PM2.5 Emissions by Fire Cause

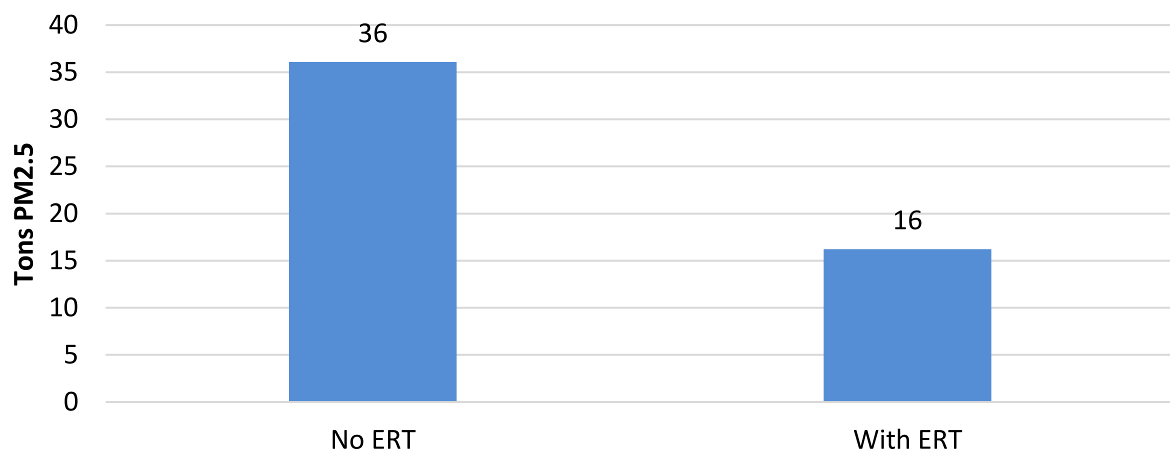


3.4 Emission Reduction Techniques

Emission Reduction Techniques (ERTs) are used to 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 2015, the application of ERTs reduced emissions by 20 tons of PM2.5 which could have occurred from the same areas during an uncontrolled burn (Figure 7). In addition to reduced emissions from the area that burns, prescribed fires are also used to reduce fuel load and create firebreaks, thereby preventing larger uncontrolled burns from occurring and potentially reducing emissions by many times more than is calculated.

Figure 7 – PM2.5 Emission Reductions from Emission Reduction Techniques (ERT)



3.5 All Pollutants

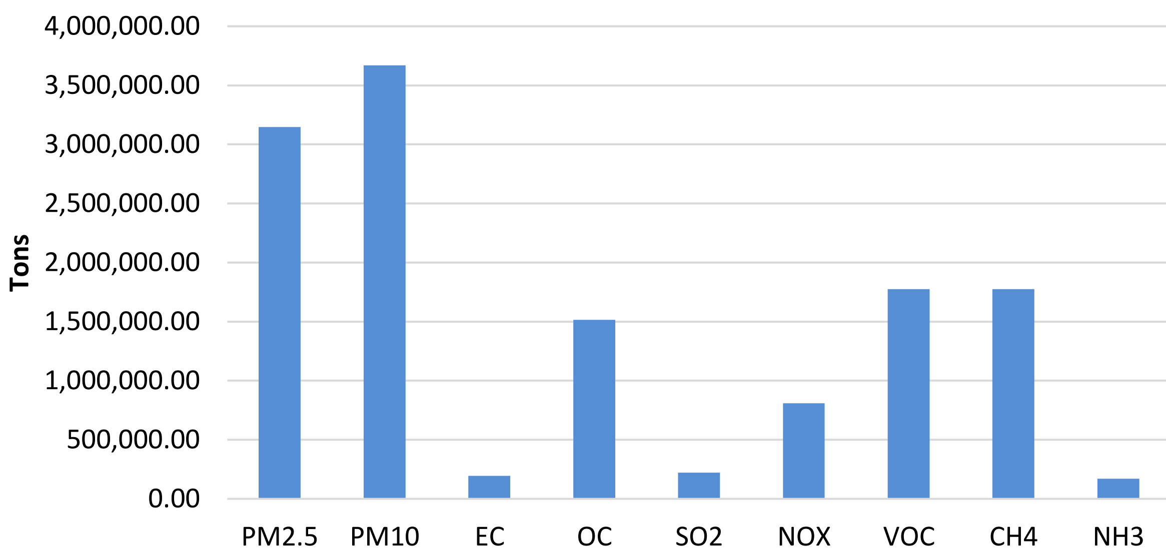
Table 4 shows the quantities of all the pollutants inventoried for this report. Particulate matter, which contributes to reduced visibility and regional haze, is of particular importance. Particulate matter 2.5 micrometers in diameter or smaller (PM2.5) comprised 86 percent of the particulate matter emitted from fires. All particulate matter has health side effects at high levels but PM2.5 is particularly noxious because of its small size and ability to penetrate deep into the lungs, causing respiratory complications and exacerbating bronchoconstriction.

Figure 8 displays the information presented in Table 4 graphically. Carbon monoxide is not shown in the Figure 8 because the quantity of it is so much greater than the other pollutants.

Table 4 – Quantities of Pollutants

Pollutant	Abbreviation	Tons
Fine particulate matter	PM2.5	3,147,159
Coarse particulate matter	PM10	3,669,509
Elemental carbon	EC	195,881
Organic carbon	OC	1,514,815
Sulfur dioxide	SO2	221,999
Oxides of nitrogen	NOX	809,643
Volatile organic compounds	VOC	1,775,990
Methane	CH4	1,775,990
Ammonia	NH3	169,764
Carbon monoxide	CO	37,739,788

Figure 8 – All Pollutants

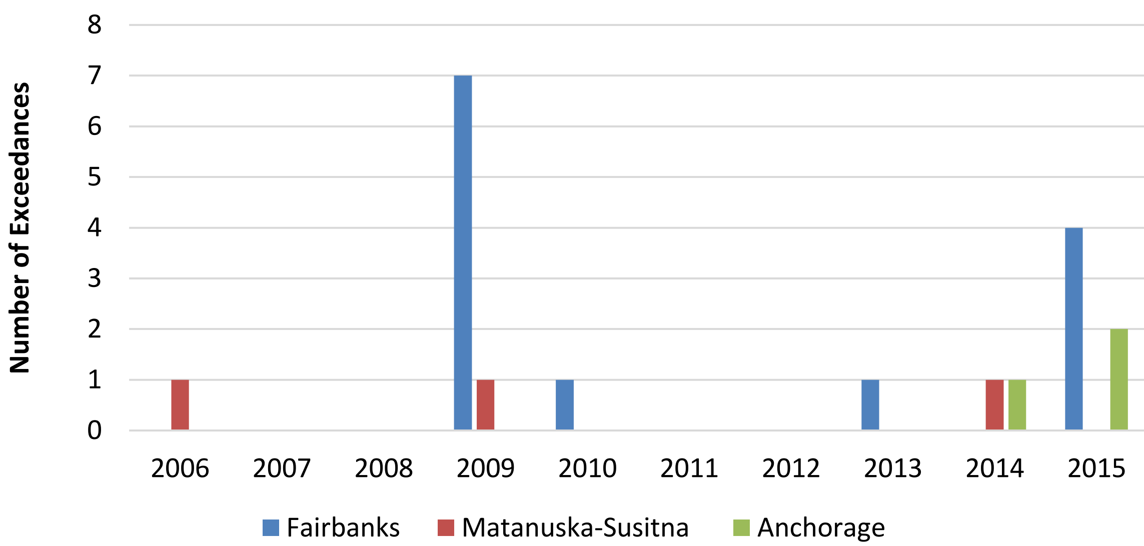


4 AIR QUALITY STANDARDS AND EXCEEDANCES

EPA sets National Ambient Air Quality Standards (NAAQS) for six criteria pollutants to protect human health. As stated, PM2.5 is the criteria pollutant of primary concern from wildland fires. An exceedance of the PM2.5 ambient air quality standard occurs when the 24-hour average concentration, measured in micrograms per cubic meter (μg/m3), exceeds 35 μg/m3. In Alaska, fine particulate matter is measured in the major population areas and one or two remote locations that can vary from year to year. Regulatory monitoring is conducted every third day, which means that smoke events can occur that are not captured in the monitoring data.

Figure 9 shows the number of exceedances recorded from 2006 to 2015 that were caused by wildfire. In 2015, exceedances were recorded in Anchorage and Fairbanks and occurred between the middle of June and the beginning of July. This correlates with the period of accelerated fire formation in the interior resulting from low fuel moistures and heavy lightning activity. As previously mentioned, the monitoring equipment only records every third day, meaning that there were likely days that weren't recorded that exceeded the NAAQS; these days could have been included in advisories however. Due to the variability in the monitoring data, the number of exceedances does not strongly correlate with the intensity of a fire year. There were two additional exceedances recorded in the winter which weren't the result of wildfires and were not included in this report.

Figure 9 –Exceedances of Air Quality Standards by Area



To address uncontrollable emissions from natural events DEC is planning to prepare an exceptional events waiver request for the exceedances recorded as a result of these fires. Exceptional events demonstrations ensure that states are not required to develop a State Implementation Plan (SIP) for uncontrollable sources of pollution. When an exceptional event demonstration is approved by the EPA, the monitored data can be 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 particulate matter. Advisories use the Air Quality Index, or AQI, to normalize air quality readings across multiple pollutants and issue standard cautionary statements. Table 5 shows the AQI levels for PM2.5 and the associated cautionary statements.

Table 5 – Air Quality Index Levels

24-Hour PM2.5 Level (µg/m3)	AQI Score	AQI Category	AQI Cautionary Statements
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.
greater than 250.5	301-500	Hazardous	Everyone should avoid any outdoor exertion; people with respiratory or heart disease, the elderly, and children should remain indoors.

Figure 10 show the numbers of advisories DEC issued compared to wildfire emissions by month. The number of air quality advisories is not necessarily dependent on the acreage burned in a year; but also related to factors such as fire location, duration, intensity, wind direction, and wind speed. However, large fire years are usually accompanied by an increased number of advisories.

Figure 10 – Air Quality Advisories Issued due to Smoke and Wildfire Emissions

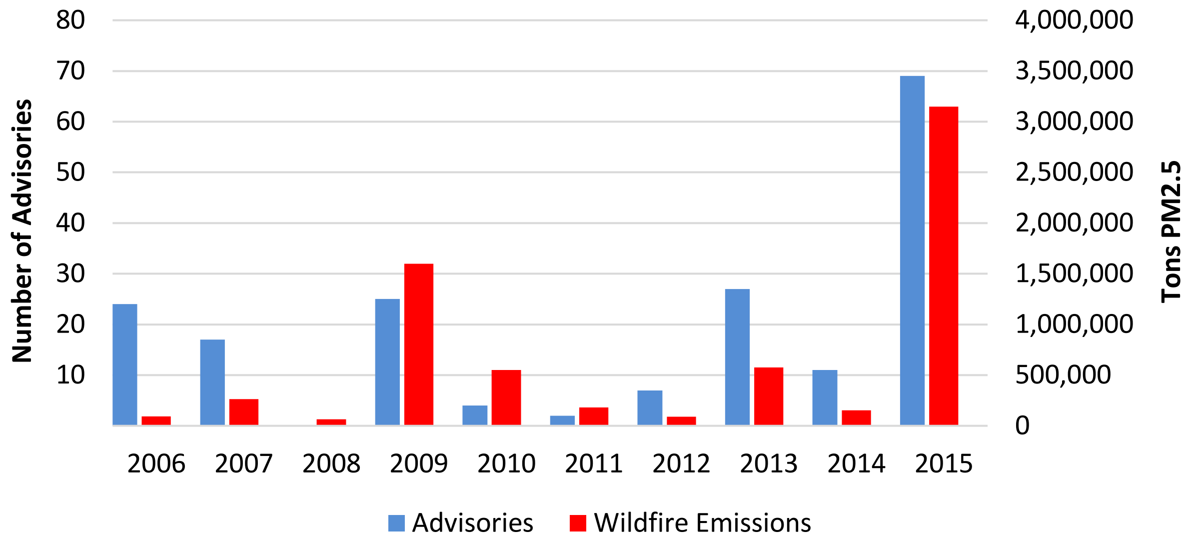
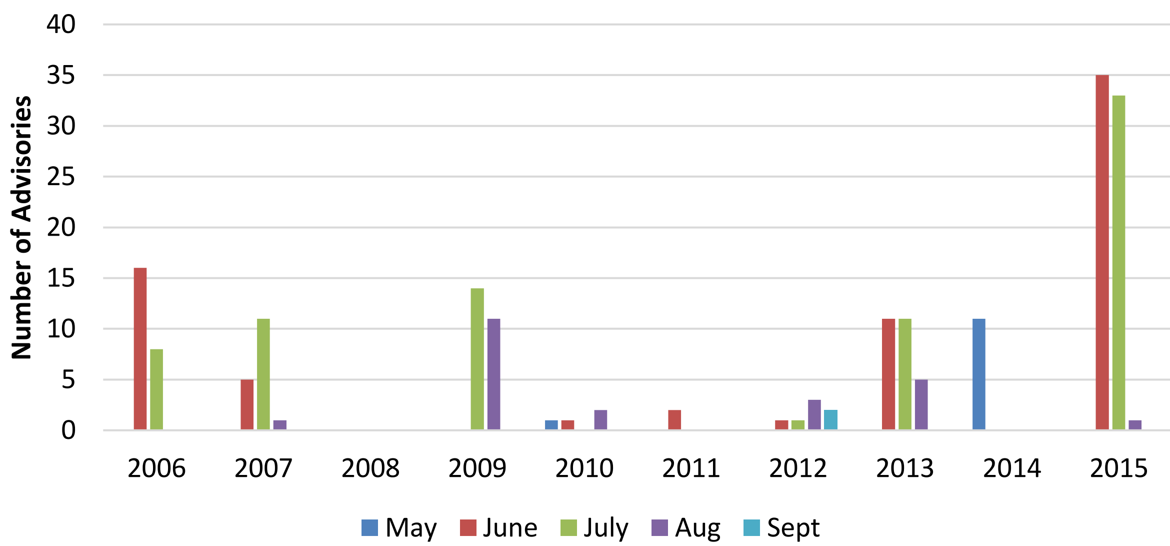


Figure 11 shows the number of advisories issued yearly by month. Most of the 69 advisories issued in 2015 by DEC were during June and July and covered multiple days. These days coincide with the period of most extreme fire activity and health risks from smoke. Multiple air quality advisories may be issued on the same day for different areas of the state, and advisories may be issued for multiple days, not just for 24 hours. In 2015, DEC issued 69 advisories covering 114 days between May and September.

Figure 11 – Number of Air Quality Advisories Issued by Month



Appendix 1 – Vegetation Types and Fuel Factors

Fuel Factor Name and Fuel Factors

Fuel Factor Name	Fuel Factor (tons per acre)
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

LANDFIRE Vegetation Types and Fuel Factors [1]

Vegetation Type Name	Fuel Factor Name 1	Fuel Factor Name 2	Fuel Factor (tons/acre)
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
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

Vegetation Type Name	Fuel Factor Name 1	Fuel Factor Name 2	Fuel Factor (tons/acre)
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
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

Vegetation Type Name	Fuel Factor Name 1	Fuel Factor Name 2	Fuel Factor (tons/acre)
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
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

Vegetation Type Name	Fuel Factor Name 1	Fuel Factor Name 2	Fuel Factor (tons/acre)
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

1: The LANDFIRE fuel factors are an average of two Basic Method fuel factors.

$$\frac{\text{Fuel Factor Name 1 value} \times \text{Fuel Factor Name 2 value}}{2} = \text{Fuel Factor}\,\frac{\text{tons}}{\text{acre}}$$

Additional information can be found in Section 2.

Isahultila LANDFIRE calculations

Fire	% Veg Type	Vegetation Type Name	Fuel Factor	Factor Contribution
Isahultila	20.82%	Western North American Boreal White Spruce Forest	57.57	11.99
Isahultila	2.45%	Western North American Boreal Spruce-Lichen Woodland	22.13	0.54
Isahultila	13.34%	Alaska Boreal White Spruce Forest	57.57	7.68
Isahultila	7.43%	Western North American Boreal Mesic Black Spruce Forest	57.57	4.28
Isahultila	8.84%	Western North American Boreal Mesic Birch-Aspen Forest	43.50	3.85
Isahultila	0.00%	Alaska Sub-boreal Avalanche Slope Shrubland	7.88	0.00
Isahultila	0.30%	Alaska Sub-boreal Mesic Subalpine Alder Shrubland	7.88	0.02
Isahultila	8.32%	Western North American Boreal Mesic Scrub Birch-Willow Shrubland	29.25	2.43
Isahultila	1.52%	Western North American Sub-boreal Mesic Bluejoint Meadow	57.57	0.88
Isahultila	0.09%	Boreal Aquatic Beds	0.75	0.00
Isahultila	1.95%	Boreal Herbaceous Wetlands	0.75	0.01
Isahultila	25.20%	Boreal Coniferous Woody Wetland	29.16	7.35
Isahultila	0.01%	Boreal Coniferous-Deciduous Woody Wetland	57.57	0.01
Isahultila	0.32%	Boreal Dwarf Shrub Wetland	7.88	0.03
Isahultila	2.14%	Boreal Forested Floodplains	36.29	0.78
Isahultila	3.36%	Boreal Black Spruce-Tussock Woodland	57.57	1.93
Isahultila	0.03%	Boreal Peatlands	7.88	0.00
Isahultila	0.02%	Boreal Riparian Stringer Forest and Shrubland	15.00	0.00
Isahultila	0.40%	Alaska Boreal Hardwood Forest	57.57	0.23
Isahultila	0.81%	Alaska Boreal White Spruce-Hardwood Forest	57.57	0.47
Isahultila	0.56%	Boreal Tussock Tundra	19.30	0.11
Isahultila	1.11%	Boreal Shrub-Tussock Tundra	19.30	0.22
Isahultila	0.71%	Boreal Shrub Floodplains	7.88	0.06

Total: **42.86**

The above example shows the calculations used to determine the Isahultila LANDFIRE fuel factor, as described above in Section 2.2.