# 2013 Alaska
# Wildfire Emissions Inventory

Prepared by the
Department of Environmental Conservation
Division of Air Quality
for the Air Quality & Smoke Management Committee
of the Alaska Wildland Fire Coordinating Group

FINAL December 29, 2014

Approved by AWFCG in January, 2015

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# 2013 Alaska Wildfire Emissions Inventory

**Summary**

The Department of Environmental Conservation (DEC) in coordination with the Alaska Wildland Fire Coordinating Group (AWFCG) developed the Alaska Enhanced Smoke Management Plan (ESMP) to reduce wildfire smoke impacts in Alaska. The ESMP and accompanying volume of appendices were adopted by the AWFCG in June 2009. According to the ESMP, DEC is responsible for collecting, reviewing, tracking, and summarizing statewide pre- and post-burn data for annual ESMP emissions inventory reports to be distributed to the AWFCG, the U.S. Environmental Protection Agency, and the Western Regional Air Partnership (WRAP).[1]

The ESMP helps fulfill Alaska's responsibilities for protection of air quality and human health under federal and state law and reflects the Clean Air Act requirement to improve regional haze in Alaska's Class I areas. The ESMP is an important component of Alaska's Regional Haze State Implementation Plan.

This report accomplishes the Department of Environmental Conservation's responsibility for reporting 2013 prescribed fire emissions as required by the Enhanced Smoke Management Plan. It also reports on the statewide wildfire emissions occurring in 2013.

In 2013, 20 prescribed fires were conducted, burning a total of 6,549 acres. The largest number of prescribed acres burned occurred in May and were conducted by or for the military. The same fire season 613 wildfires burned a total of 1,316,288.5 acres.[2] The wildfire acreage burned was the fourth highest of the past ten years. There was one wildfire reported in February and seven reported in April, but the majority of wildfires occurred May through August in the northern half of the state.

The ten wildfires producing the most PM2.5 emissions created approximately 276,579 tons of PM2.5, which was close to 48.1% of the total tons of PM2.5 produced by all 613 wildfires. Those same ten wildfires burned approximately 833,752.4 acres which was about 63.1% of the total acres burned.

The Alaska Interagency Coordination Center (AICC) is the Geographic Area Coordination Center for Alaska. Located on Ft. Wainwright, near Fairbanks, the AICC serves as the focal point for initial attack resource coordination, logistics support, and predictive services for all state and federal agencies involved in wildfire management and suppression in Alaska.[3]

The AICC operates on an interagency basis – cooperators include the Bureau of Land Management, State of Alaska Department of Natural Resources (including the Division of Forestry), USDA Forest Service, National Park Service, Bureau of Indian Affairs, and the Fish and Wildlife Service.[4] The AICC collects most wildfire related data into daily situation reports, available on their website: http://fire.ak.blm.gov/predsvcs/intel.php

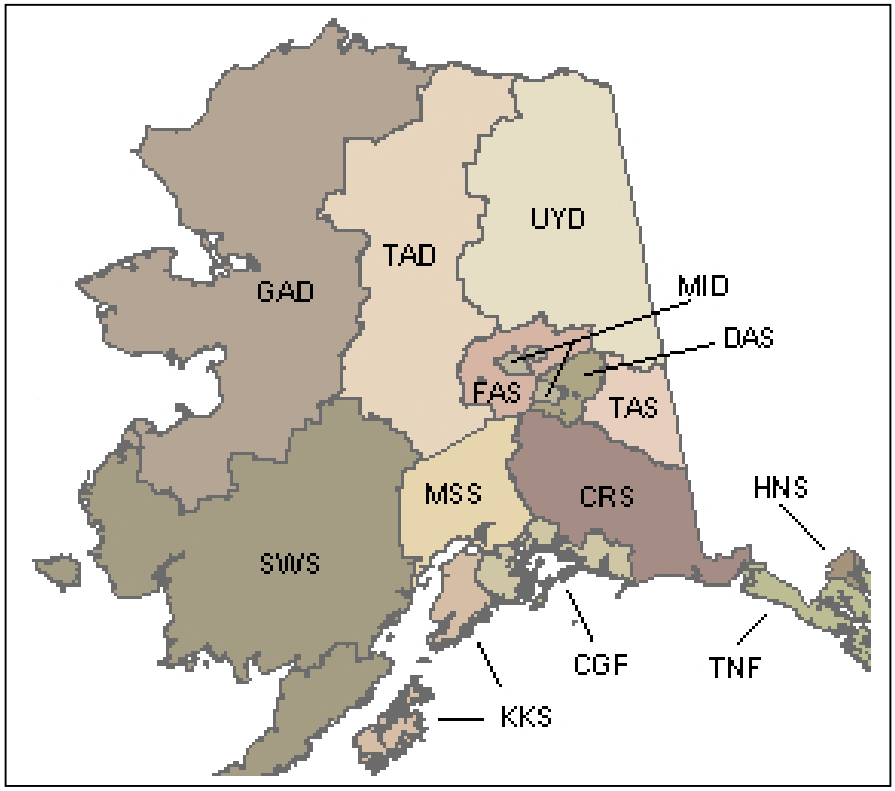
Fire management planning, preparedness, suppression operations, prescribed fire, and related activities are coordinated on an interagency basis (i.e., the AICC). The Division of Forestry, Bureau of Land Management, and the U.S. Forest Service fight fires within their protection areas on all land ownerships,

[1] Alaska Enhanced Smoke Management Plan for Planned Fire, Procedures Manual, Executive summary, June 2009
[2] As reported in the Alaska Interagency Coordination Center's Fire Report, http://fire.ak.blm.gov/predsvcs/intel.php
[3] Alaska Interagency Coordination Center website: http://fire.ak.blm.gov/aicc.php
[4] ibid

which reduces the duplication of facilities and services. The state and federal agencies routinely utilize each other's personnel and resources to both manage and fight fires for efficiency and cost effectiveness.[5]

The 14 Alaska Fire Management Zones are shown on the map below. These zones are as follows:

- 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)
- 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)




[5] Division of Forestry Fire Program website: http://forestry.alaska.gov/fire/

**Method for 2013 Alaska Wildfire Emissions Inventory**

The Wildland Fire Emission Template prepared in 2006 by Air Sciences, Inc. for the Department of Environmental Conservation (DEC) was used to prepare the 2013 wildfire inventory. The template, after input of appropriate data, graphs and summarizes the fire and emissions data. Using the template provides a consistent analysis of fire data from year to year. As in 2012, the Air Quality and Smoke Management Committee approved using LANDFIRE vegetative types, provided by the Department of Natural Resources, Division of Forestry, for the 20 largest fires. This data provided greater detail of the vegetation within the fire perimeter, compared to the vegetation type noted at the fire start. These 20 fires burned approximately 81.5% of the total acreage burned in 2013. Additional information about the use of LANDFIRE data for 2013 can be found in the Appendix, Section A, Emission Factors Used section.

A summary of the 2013 fires, their type, start and end dates, 'owner,' locations, and acreages was provided to DEC by the Division of Forestry. The data was copied into the template. The dates were re-entered to conform to the template requirements. The 'emission factor' for each fire, as determined by the vegetative type listed in the electronic version of the AICC daily situation report, the description in the pdf version of the daily situation report or the LANDFIRE vegetation types, was also input. The majority of fires which did not have a vegetation type listed were 0.1 – 0.2 acre in size. Since most of the other fires of those sizes were grass fires, those unknown vegetation type fires were given the grass emission factor.

The wildfire acreage received from the AICC annual Fire Report for 2013 was 0.3% less than the acreages derived from the AICC tables obtained from the website during the active fire season in 2013. The reduction was primarily due to digitalizing borders for greater accuracy of burned acreage.

The fires in the emission inventory are categorized into two groups: prescribed fires and wildfires. The category of "Wildland Fire Use" is now obsolete and has not been used by agencies since the 2008 fire season in describing and tracking fires. In the past, this category described the management of either wildfire or prescribed fire to meet resource objectives or benefits. The National Wildfire Coordinating Group ceased to use this term because a wildland fire may be concurrently managed for one or more objectives and objectives can change as fire moves across the landscape. As a result, this category is no longer recorded as a separate category.[6]

The following definitions are taken from the 2009 Alaska Enhanced Smoke Management Plan for Planned Fire.

- **Prescribed Fire**, or controlled burn, is any fire ignited by management actions to meet specific objectives. A written, approved prescribed fire plan must exist. In a federal action, National Environmental Policy Act requirements must be met prior to ignition. Prescribed fire is a type of open burning.

- **Wildfire** is any non-structure fire, other than prescribed fire, that occurs in the wildland. Wildland is an area where development is generally limited to roads, railroads, power lines, and widely scattered structures. The land may be neglected altogether or managed for such purposes as wood or forage production, wildlife, recreation, wetlands, or protective plant cover.

[6] NWCG Memorandum Ref# NWCG024-2010, Terminology Updated Resulting from Release of the *Guidance for the Implementation of Federal Wildland Fire Management Policy (2009)*, April 30, 2010.

**Discussion of Results**

The Fire Emission Template presents results through graphs. Figures 1 through 12 are discussed on this and the following pages. A listing of the emission factors used for vegetation groups is provided in Appendix A.

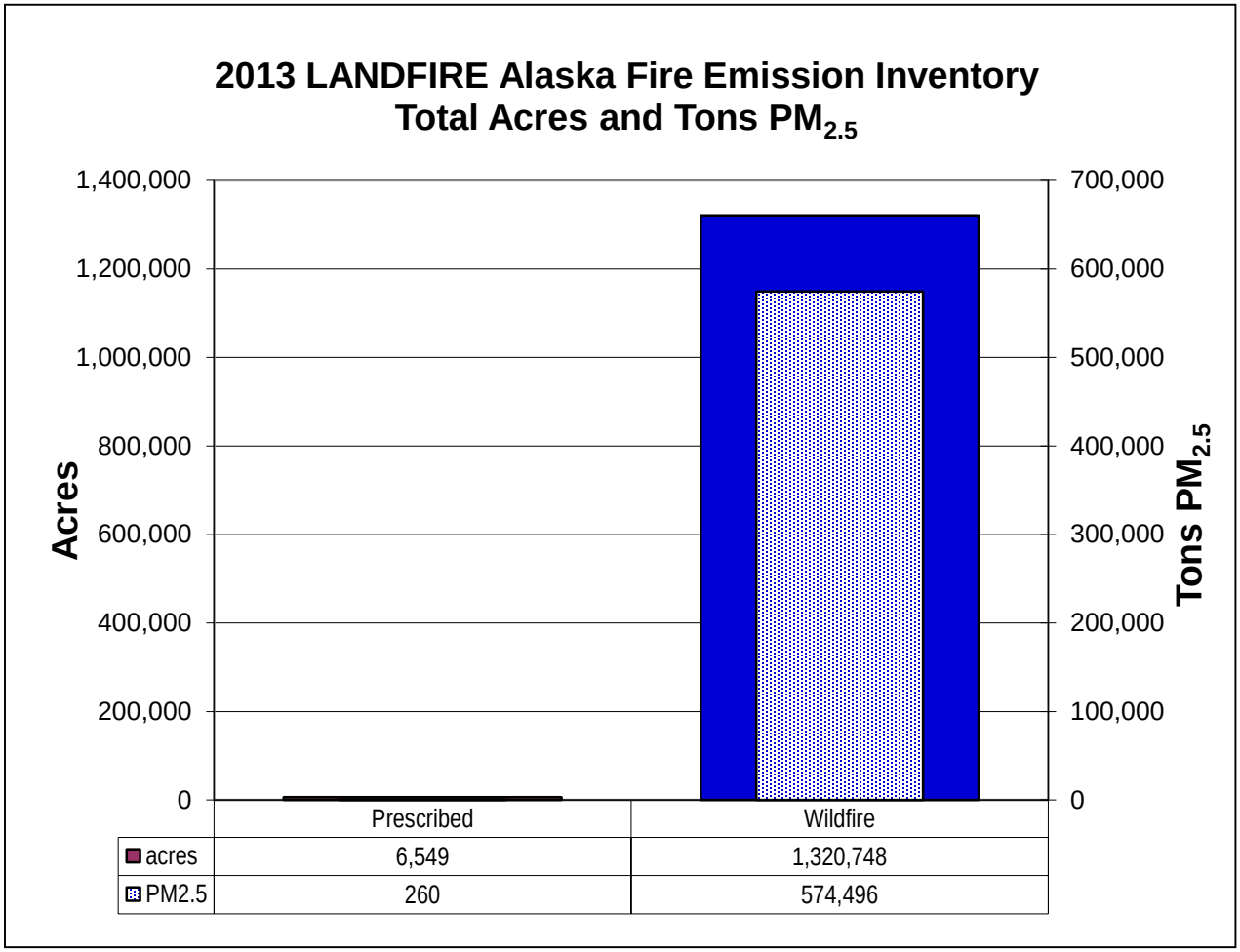
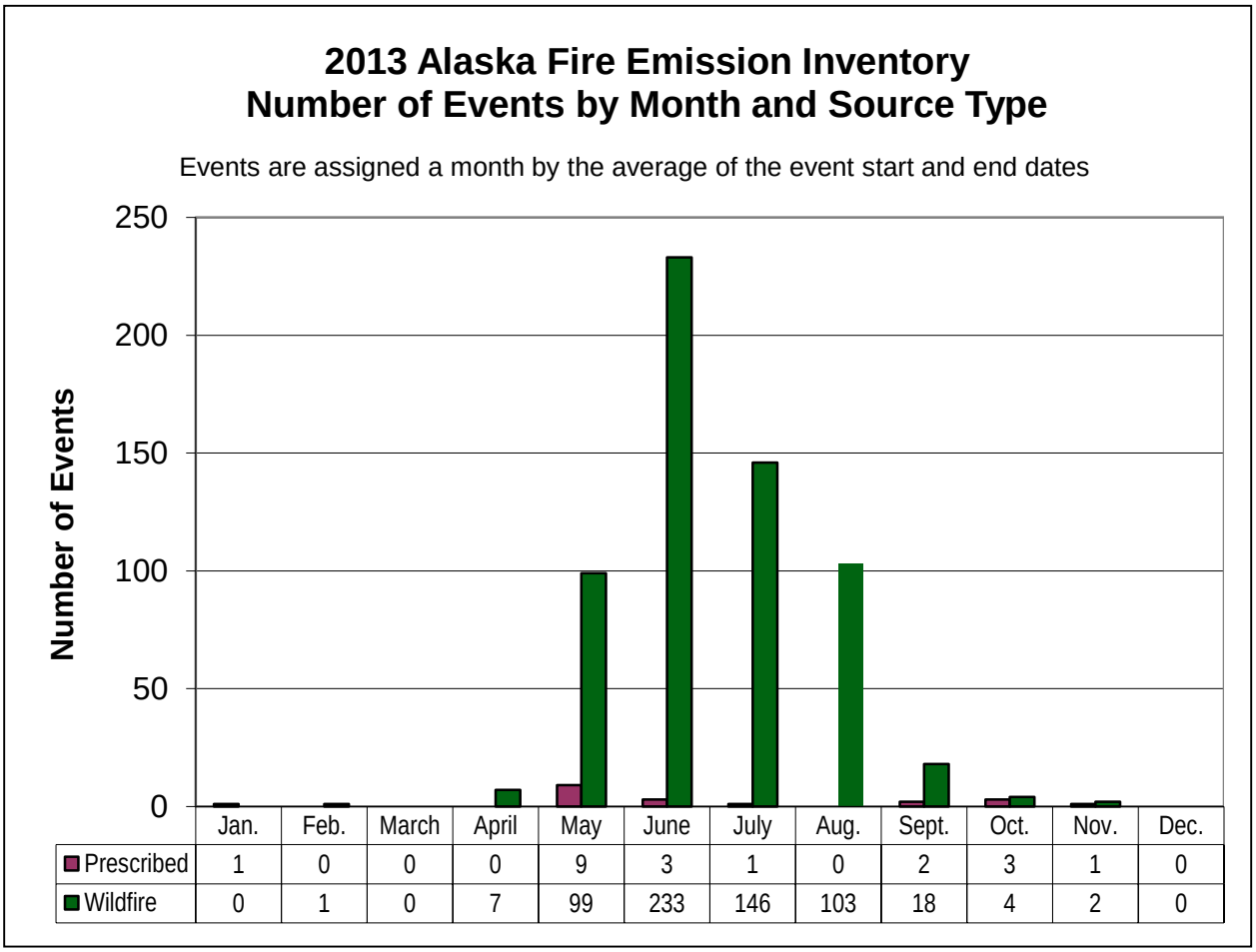



FIGURE 1

Figure 1 shows the number of acres burned and the tons of $PM_{2.5}$ produced for both fire types (prescribed and wildfire) during the 2013 season.

- Prescribed fires were approximately 0.5% (6,549 acres) of the total 2013 Alaskan fires, producing 260 tons of $PM_{2.5}$ (less than one percent) of the total $PM_{2.5}$.

- Wildfires were approximately 99.5% (1,320,748 acres) of the total 2013 Alaskan fires, producing 574,496 tons of $PM_{2.5}$ (over 99%) of the total $PM_{2.5}$.




| | Jan. | Feb. | March | April | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Prescribed | 1 | 0 | 0 | 0 | 9 | 3 | 1 | 0 | 2 | 3 | 1 | 0 |
| Wildfire | 0 | 1 | 0 | 7 | 99 | 233 | 146 | 103 | 18 | 4 | 2 | 0 |

FIGURE 2

Figure 2 shows the total number of wildfires in 2013, by month and fire type, prescribed or wildfire.

The month with the most prescribed burns was May (9 burns, 45%). The other prescribed burns occurred in January, June, July, September, October, and November for a total of 11 burns or 55%.

Most of the wildfires occurred during the summer months of May, June, July, and August (94.8%, 581 fires), with one fire in February, and seven fires in April (8 fires total, 1.3%). There were 24 fires spread from September through November (3.9%). Most of the fires in April and the first couple weeks of May were small, escaped residential grass fires or small burn pile fires of 0.3 acre or less in size.

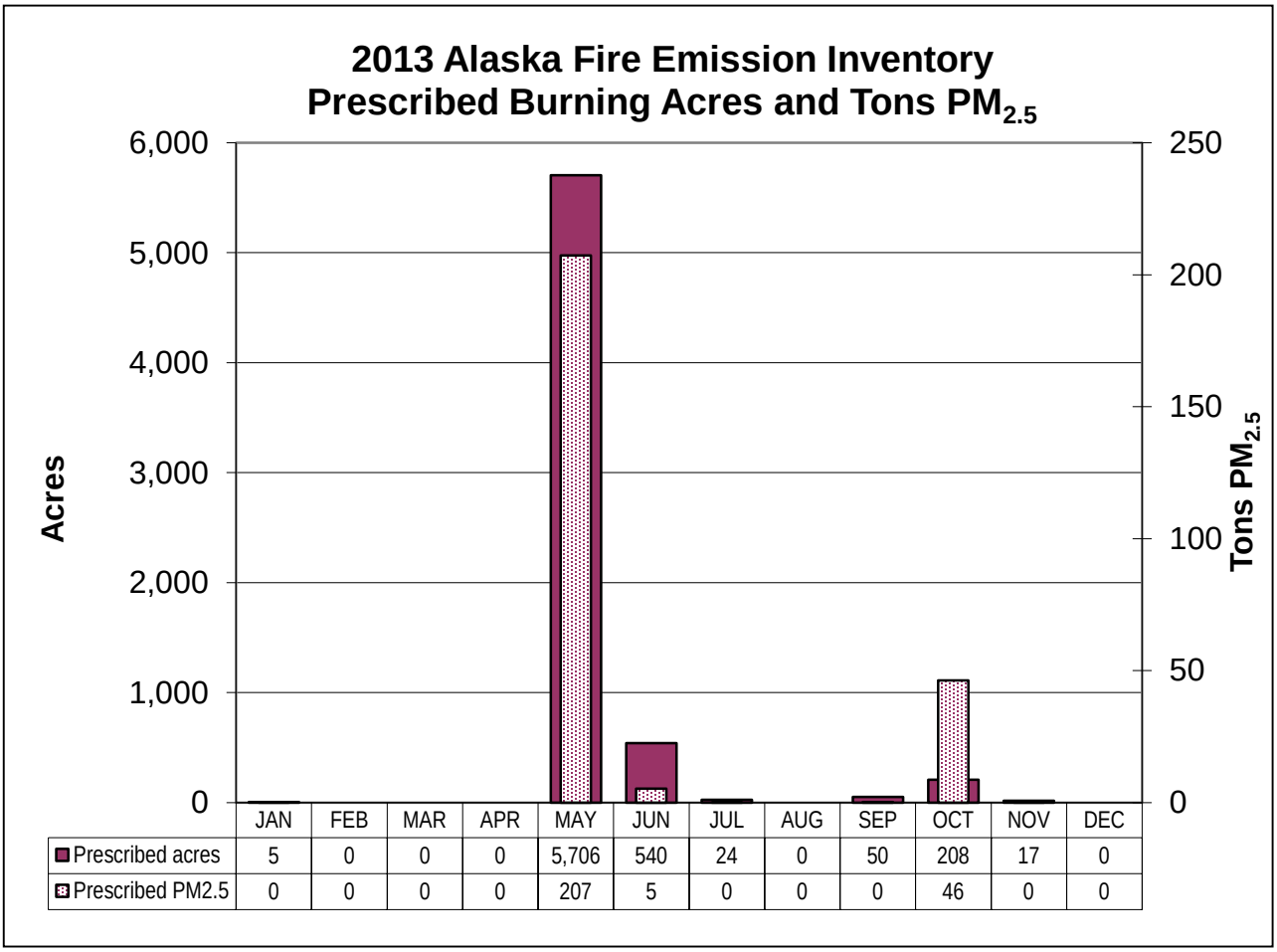



FIGURE 3

Figure 3 shows the acres of prescribed burns and tons of $PM_{2.5}$ produced in 2013.

Almost all of the prescribed fire burns were conducted during May and June. October was the third largest month for acreage (208 acres, 3.2%) and second largest for tons of $PM_{2.5}$ produced (46 tons, 17.7%).

Prescribed burns conducted through May were primarily broadcast (fire burned in mostly grassland, areas with little or no forest stand present); two of the burns conducted September through November were piled burns and the other two were broadcast.

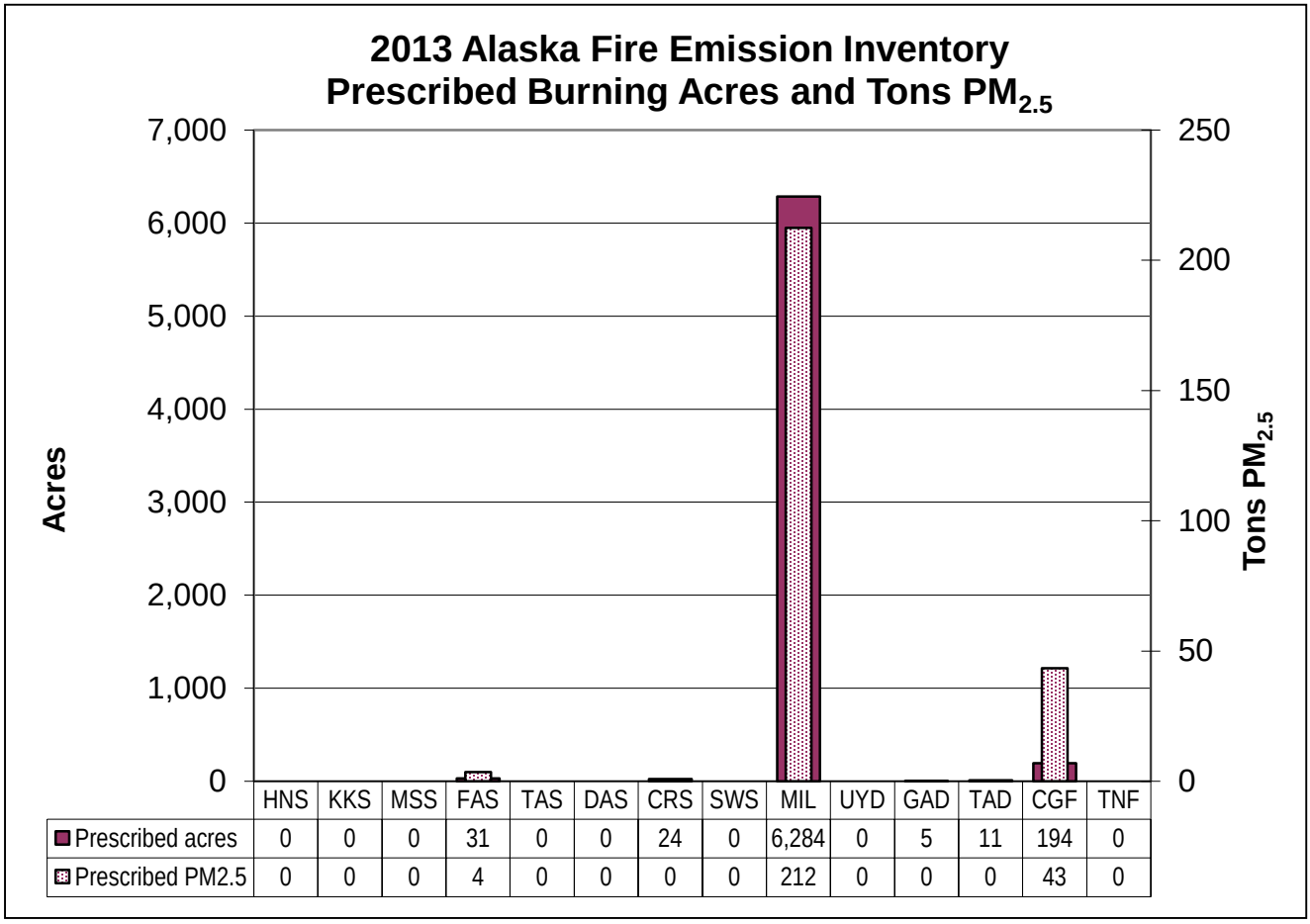



FIGURE 4

Figure 4 shows the acres of prescribed burns and the tons of $PM_{2.5}$ produced by Fire Management Zone. A map of the Fire Management Zones is on Page 5.

The Military (MIL) burned most of the prescribed burn acres in 2013 (6,284 acres or 95.9%) and consequently produced most of the tons of $PM_{2.5}$ (212 tons or 81.5%).

Chugach National Forest (CGF) had the second highest prescribed burn acreage (194 acres or 3.0%) and $PM_{2.5}$ tons (43 tons or 16.5%) produced in 2013.

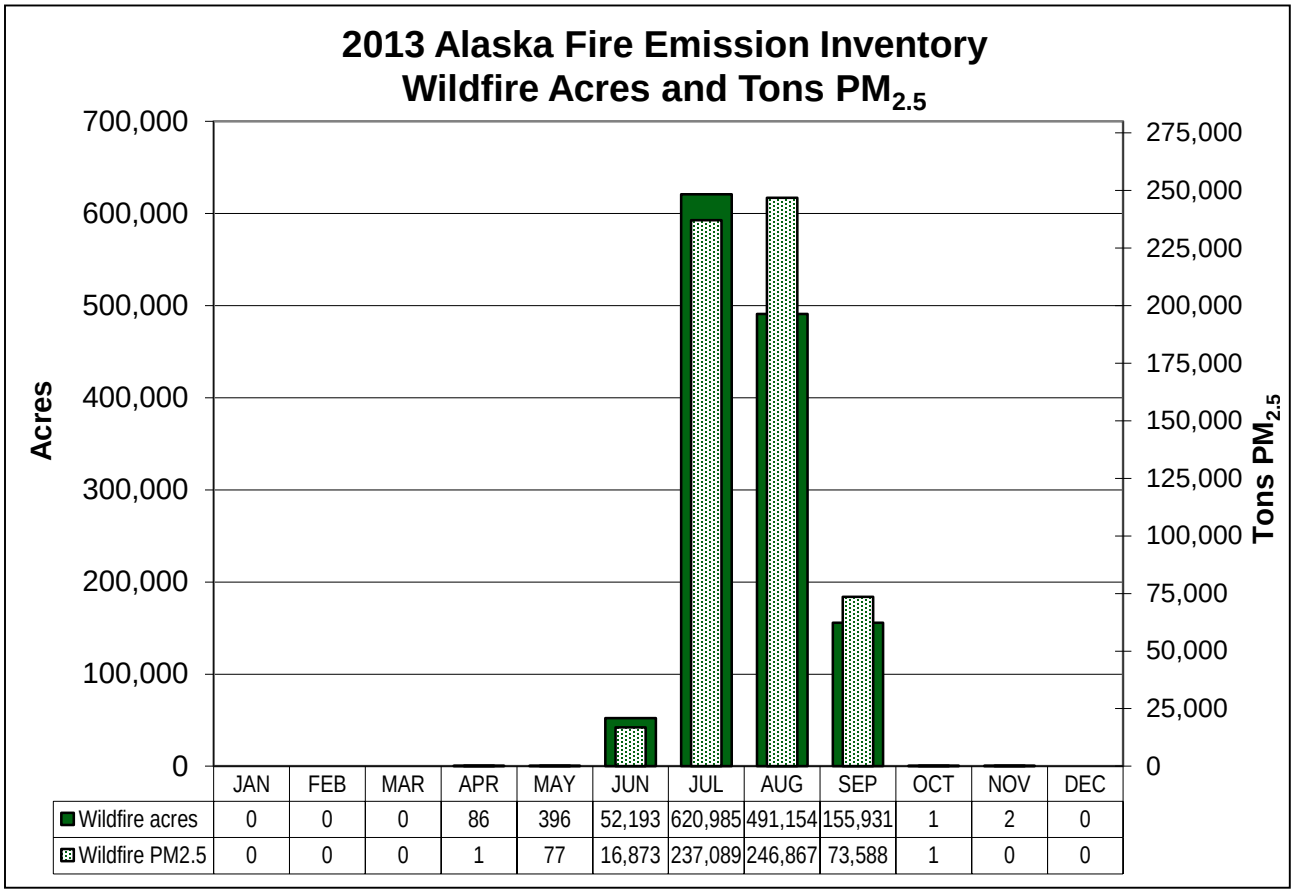
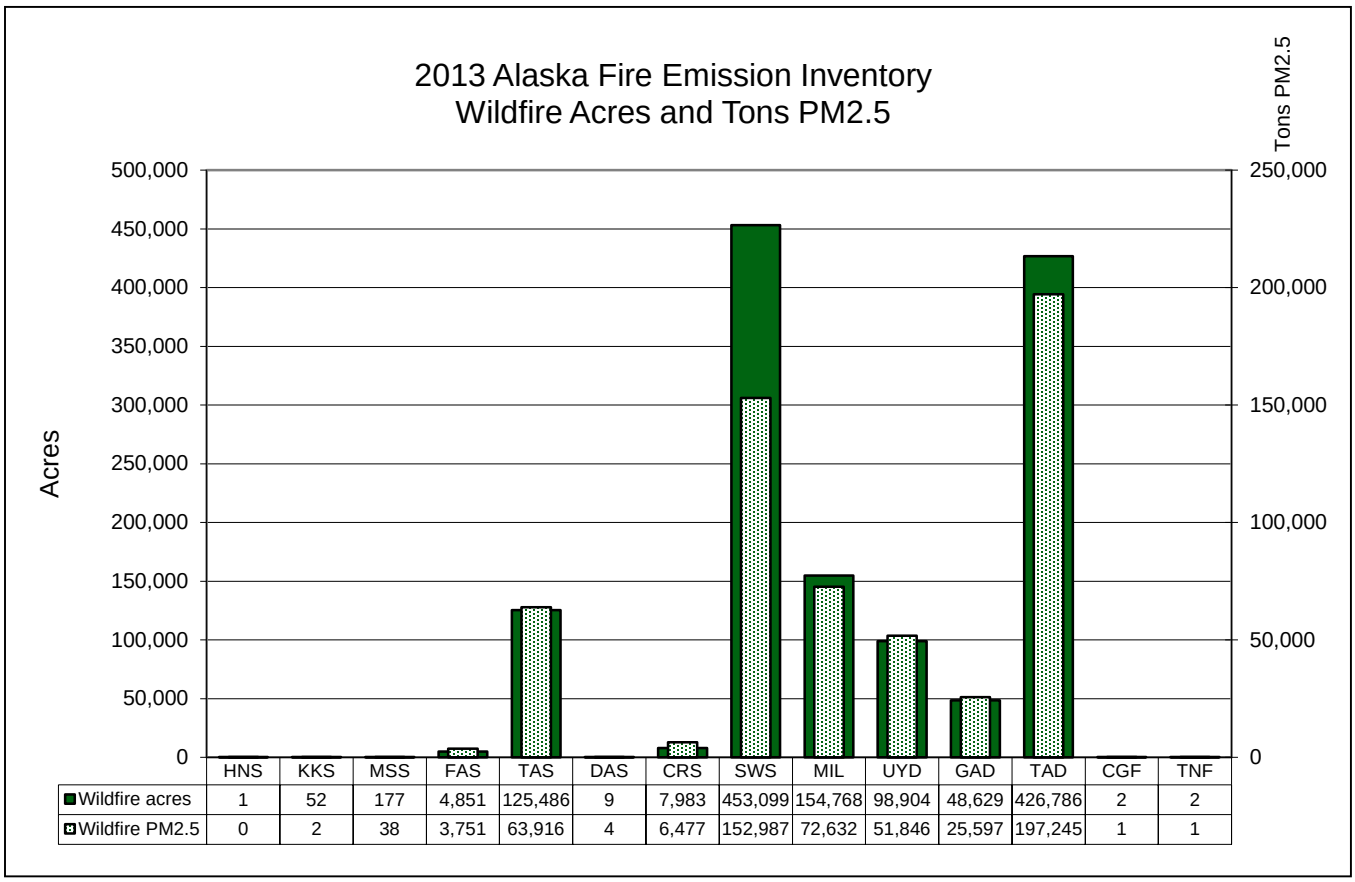



FIGURE 5

Figure 5 shows the wildfire acres and tons of $PM_{2.5}$ by month.

Wildfire starts occurred April through November in 2013. July and August were the months calculated by the template to have the largest acreage burned: 620.985 and 491,154, respectively, for a total of 84 % of the acres burned for the year. These two months also produced the most emissions: 237,089 and 246,867 tons of $PM_{2.5}$, respectively, also 84% of the season total. September had the third largest wildfire acreage burned: 155,931 acres burned (11.8%) and 73,588 tons of $PM_{2.5}$ produced (12.8%). The remaining months accounted for 5,267.8 (4.0%) acres burned and produced 16,952 (3.0%) tons of $PM_{2.5}$.

The template averages the 'month' of the fire between the start and end dates, i.e., a fire with a start in June may not be called out until August; the template would call this fire a 'July' fire whether or not most of the active burning was in June, July, or August.




| | HNS | KKS | MSS | FAS | TAS | DAS | CRS | SWS | MIL | UYD | GAD | TAD | CGF | TNF |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Wildfire acres | 1 | 52 | 177 | 4,851 | 125,486 | 9 | 7,983 | 453,099 | 154,768 | 98,904 | 48,629 | 426,786 | 2 | 2 |
| Wildfire PM2.5 | 0 | 2 | 38 | 3,751 | 63,916 | 4 | 6,477 | 152,987 | 72,632 | 51,846 | 25,597 | 197,245 | 1 | 1 |

FIGURE 6

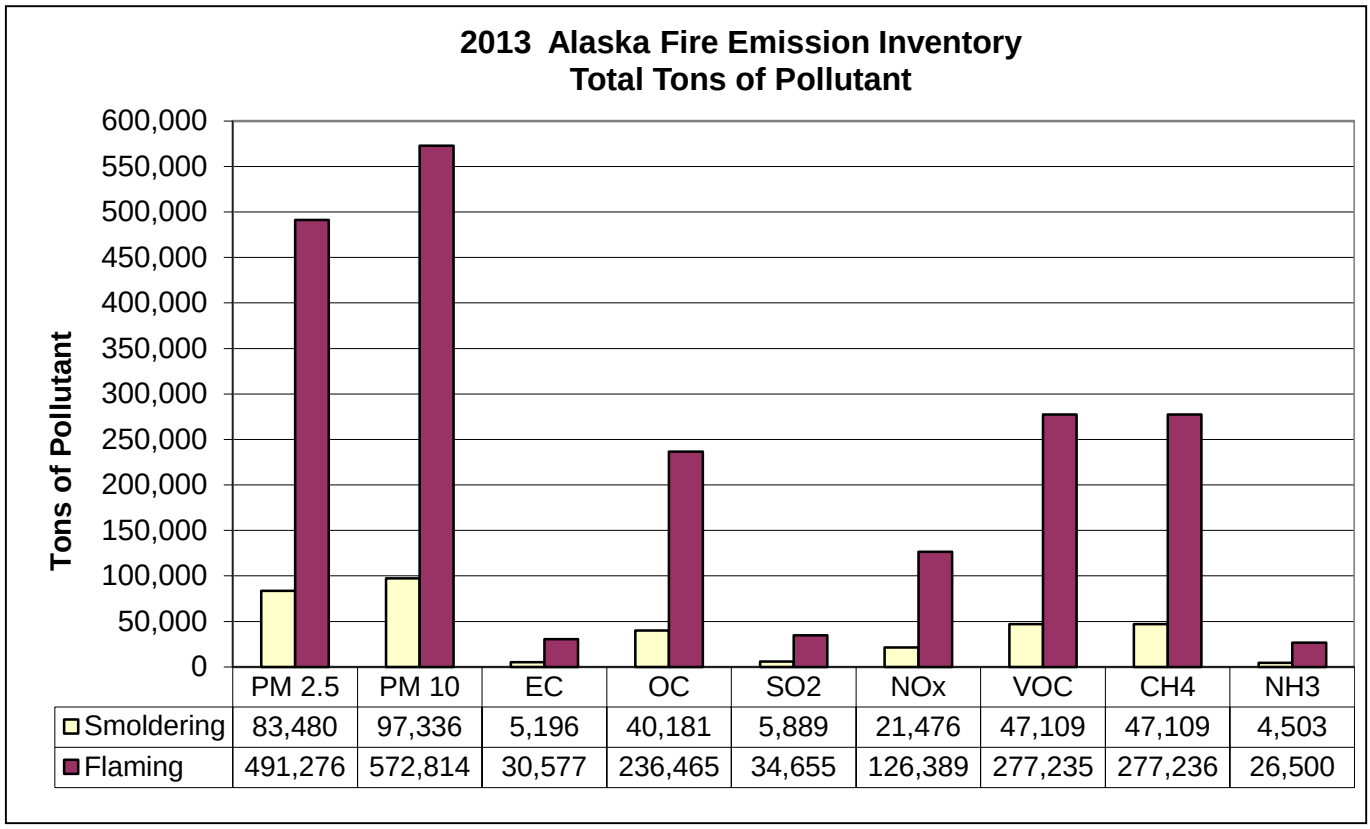
Figure 6 shows the wildfire acres and tons of $PM_{2.5}$ by Fire Management Zone. A map of the Fire Management Zones is on Page 5.

All 14 Fire Management Zones reported wildfires. Five zones (Haines (HNS), Kenai-Kodiak (KKS), Delta Area Forestry (DAS), Chugach National Forest (CGF), and Tongass National Forest (TNF)) reported less than 100 acres burned for 2013.

The five Fire Management Zones reporting the most acreage burned by wildfire also produced the most tons $PM_{2.5}$. The numbers are shown on the above chart, percentages are below.

- Southwest District (SWS) 34.1% acres 26.6% tons $PM_{2.5}$
- Tanana Fire Management Zone (TAD) 32.2 % acres 34.3% tons $PM_{2.5}$
- Military (MID / MIL) 11.7% acres 12.6% tons $PM_{2.5}$
- Tok Area Forestry (TAS) 9.4% acres 11.1% tons $PM_{2.5}$
- Upper Yukon District (UYD) 7.5% acres 9.0% tons $PM_{2.5}$

The remaining nine Fire Management Zones (HNS, KKS, MSS, FAS, DAS, CRS, GAD, CGF, and TNF) reported 5.1% of the total acreage burned and 6.4% of the $PM_{2.5}$ produced.




| | PM 2.5 | PM 10 | EC | OC | SO2 | NOx | VOC | CH4 | NH3 |
|---|---|---|---|---|---|---|---|---|---|
| Smoldering | 83,480 | 97,336 | 5,196 | 40,181 | 5,889 | 21,476 | 47,109 | 47,109 | 4,503 |
| Flaming | 491,276 | 572,814 | 30,577 | 236,465 | 34,655 | 126,389 | 277,235 | 277,236 | 26,500 |

FIGURE 7

Figure 7 shows the total tons of pollutant produced by the 2013 fires for nine different air pollutants.

The graph shows the flaming and smoldering tons of the air quality pollutants from wildfires and prescribed burns. The emission factors (EF) for the pollutants, shown below, are also used in the template, and are based on the Western Regional Air Partnership (WRAP) Phase II 2002 fire emissions inventory (Air Sciences, Inc., 2004, 2005). The template calculated smoldering tons only if the emission factor of the fire was '5' or greater.

| **Pollutant** | **Symbol** | **Name in Figure 7** | **EF Broadcast Burns (lbs/ton)** | **EF Piled Burns (lbs/ton)** |
|---|---|---|---|---|
| fine particulate matter | $PM_{2.5}$ | PM 2.5 | 24.1 | 8.0 |
| coarse particulate matter | $PM_{10}$ | PM 10 | 28.1 | 8.0 |
| elemental carbon | EC | EC | 1.5 | 0.6 |
| organic carbon | OC | OC | 11.6 | 4.3 |
| sulfur dioxide | $SO_2$ | SO2 | 1.7 | 1.7 |
| nitrogen oxides | $NO_X$ | NOx | 6.2 | 6.2 |
| volatile organic compounds | VOC | VOC | 13.6 | 6.3 |
| methane | $CH_4$ | CH4 | 13.6 | 7.7 |
| ammonia | $NH_3$ | NH3 | 1.3 | 0.5 |

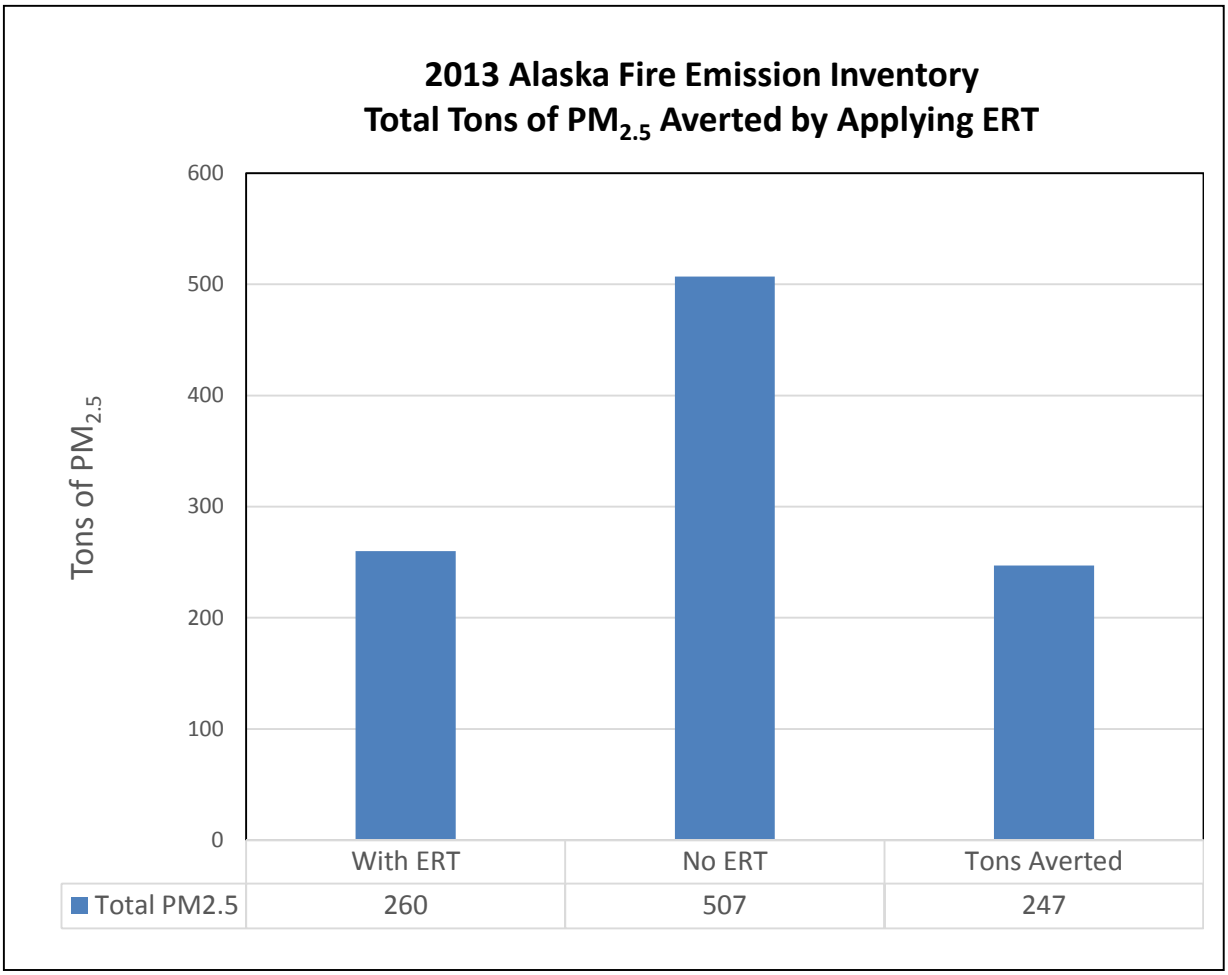



FIGURE 8

Figure 8 shows the total tons of $PM_{2.5}$ averted by applying an Emission Reduction Technique (ERT) before or during a prescribed burn.

The graph shows the total tons of $PM_{2.5}$ with Emission Reduction Techniques, what the numbers would have been without ERTs, and the 247 tons of $PM_{2.5}$ (48.7%) averted with the use of ERTs during prescribed burns. The emission reduction techniques used during prescribed burns greatly reduce the tons of $PM_{2.5}$ produced.

During 2013, the most commonly used ERTs on broadcast fires was ring-firing the unit with multiple firing teams using drip torches and flare guns to obtain maximum smoke loft. Firing could be halted if conditions became unfavorable. Firing was also done during the hottest part of the day. An ERT used on burn piles was to clear the snow from the pile several days before ignition to help lower the moisture content of the pile.

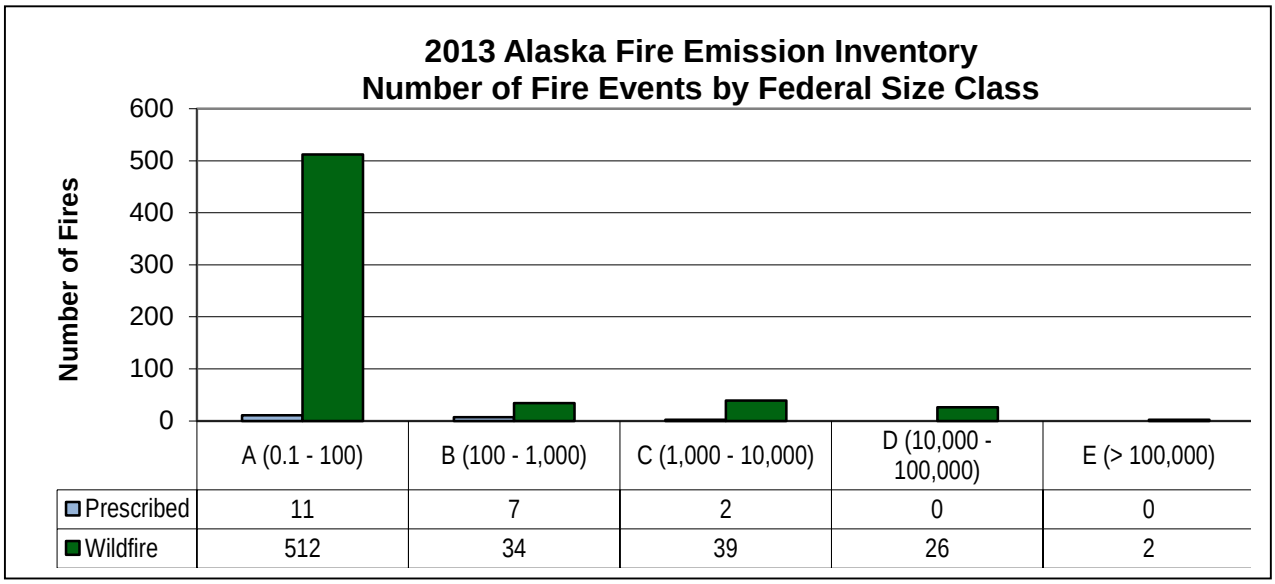



FIGURE 9

Figure 9 shows the number of fire events by Federal size class and Figure 10 shows the total tons of $PM_{2.5}$ per Federal size class. The wildfire category is the larger in each of the federal fire size classes, ranging from Class A (0.1 to 100 acres) to Class E (greater than 100,000 acres).

In 2013, there were a total of 523 fires (82.6%) in the Class A size (less than 100 acres), 41 fires (6.5%) in Class C (1,000 to 10,000 acres), and two fires (0.3%) in Class E (greater than 100,000 acres). As shown by the chart, Federal Class A was the largest size fire category for both prescribed fires and wildfires. Alternately, as shown by Figure 10, the wildfire size category D, just 26 fires (4.2%), produced the most particulates (65.7%).

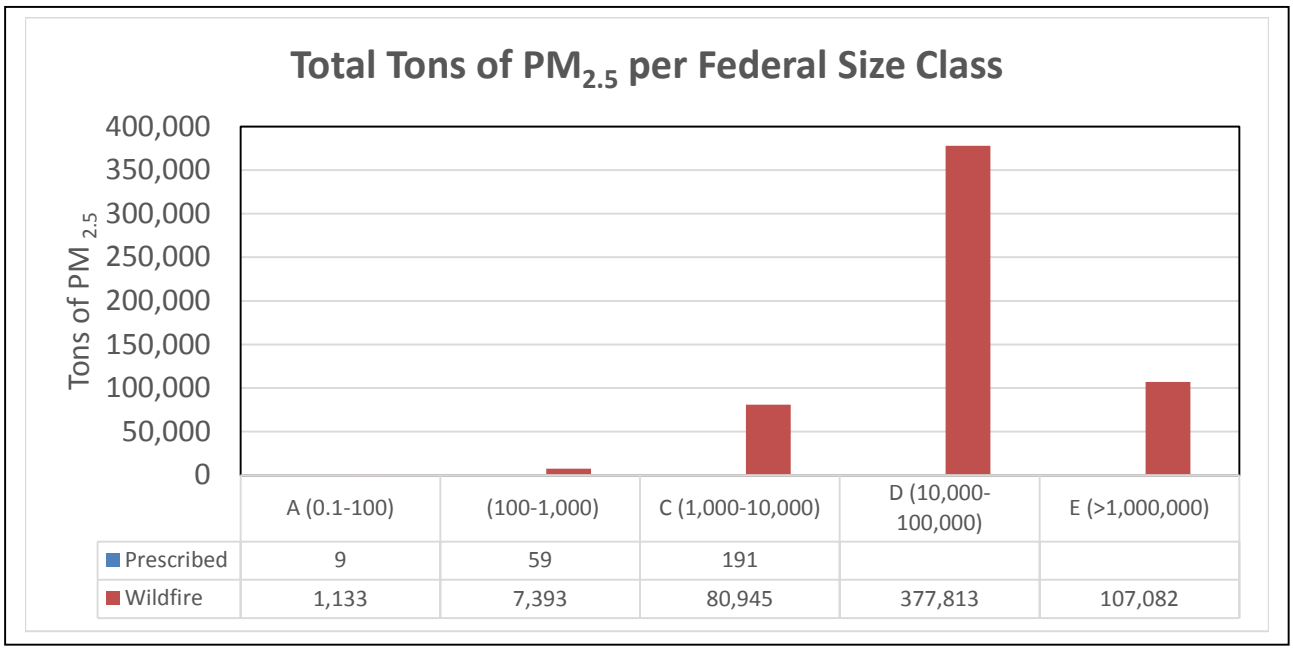



FIGURE 10

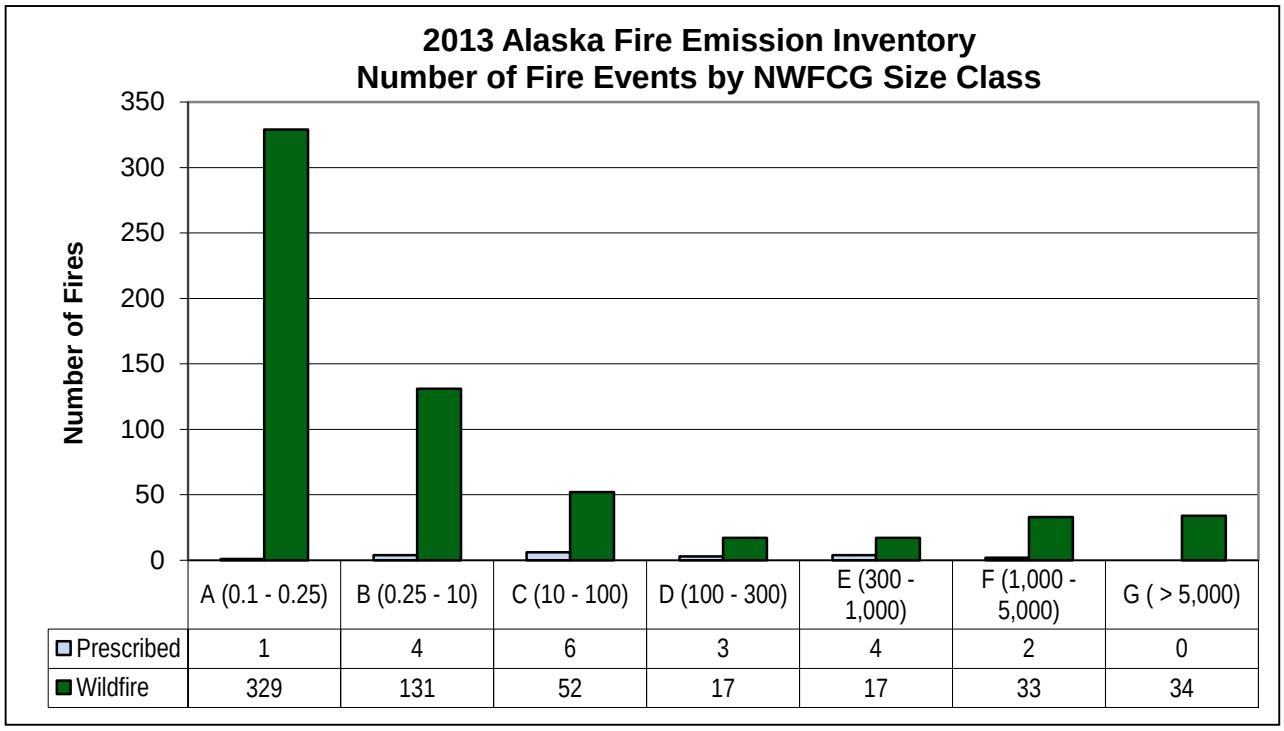



FIGURE 11

Figure 11 shows the number of fire events by National Wildland Fire Coordinating Group (NWFCG) size class and Figure 12 shows the total tons of $PM_{2.5}$ per NWFCG size class.

The wildfire category is the larger in each of the NWFCG fire size classes in Figures 11 and 12. In 2013, 73.8% of the fires were less than 10 acres, and 52.1% were less than 0.25 acre. There were 34 fires (5.4%) larger than 5,000 acres. Those 34 fires produced 88.9% of the total tons PM2.5. Fires less than 100 acres in size produced minimal PM2.5 emissions in 2013 (0.2%).

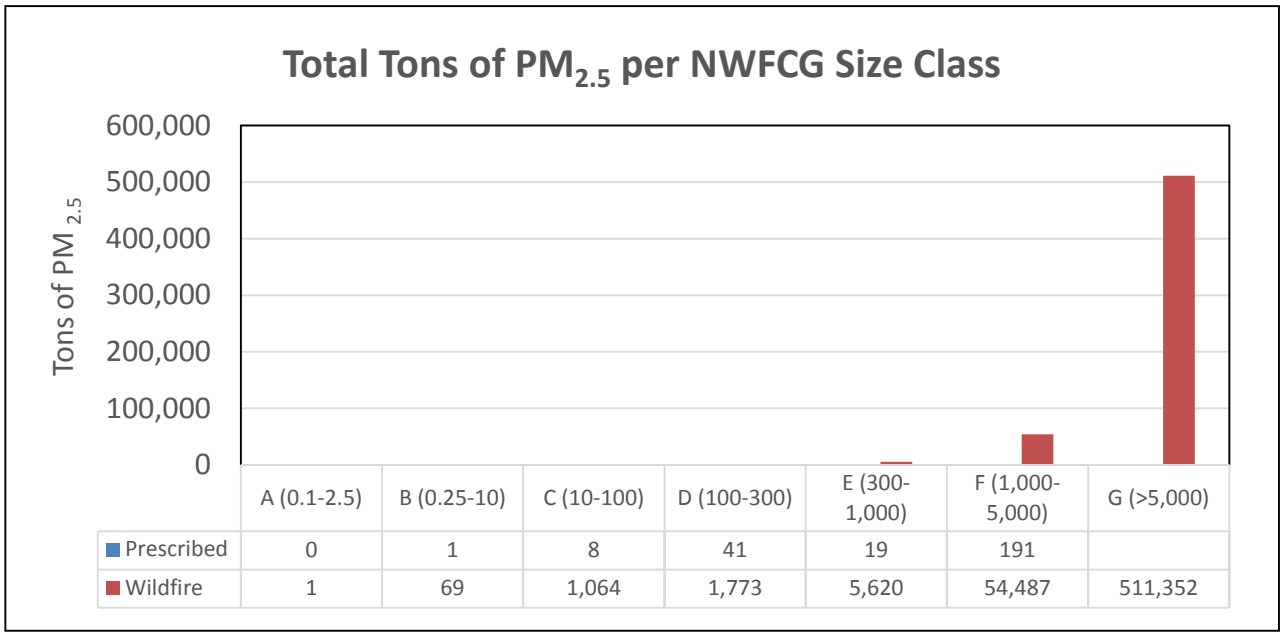



FIGURE 12

# Appendix

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## A. 1. Emission Factors Used

The Emission Factors (tons/acre), shown on this page and the next, were used for the various vegetation types and mixes found in wildfires. When two vegetation types were listed in the AICC situation report for a specific fire, the two vegetation emission factors (EF) were added together and roughly divided by two to come up with an average emission factor for the fire.

In 2013, for the 20 largest fires, the Air Quality and Smoke Management Committee again supported using LANDFIRE vegetation types to more accurately determine emission factors. The vegetation types were determined post-fire for the 20 wildfires. The 49 vegetation types were assigned emission factors to match the values used in prior years.

In future years, LANDFIRE vegetation types will continue to be used for a minimum of 12 wildfires, or the number of fires it takes to reach 80% of the fire acreage burned. The LANDFIRE vegetation types and the assigned emission factors are shown on the following page. When multiple vegetation types were mapped, the emission factors were weighted by percent and a single number was calculated for the fire.

The Canadian Forest Fire Danger Rating System (CFFDRS) served as the primary source of emission factors as it is used by the BLM Alaska Fire Service.[7]

| | Wildfire EF | Prescribed EF |
|---|---|---|
| Grasses - Western perennial | 0.75 | 0.75 |
| Intermediate brush | 15 | 15 |
| Black spruce Alaskan | 57.57 | 48.76 |
| Black spruce (57.57) and brush (15) | 36 | |
| Black spruce (57.57) and tundra (12) | 34.5 | |
| Black spruce (57.57) and grass (0.75) | 29 | |
| Black spruce (57.57) and white spruce (30.35) | 45 | |
| Spruce and hardwoods estimate | 44 | |
| Tundra (~avg 19.05 and 4.45) | 12 | |
| Tundra (12) and grass (0.75) | 6.5 | |
| Tundra (12) and brush (15) | 13.5 | |
| Tundra (12) and white spruce (30.35) | 24 | |
| Brush (15) and grass (0.75) | 8 | |
| Grass (0.75) and hardwoods (30.35) estimate[8] | 6 | |
| Grass (0.75) and slash (14.35) | 7.5 | |
| Tussocks / peat estimate | 8.5 | |
| Old burn estimate | 20 | |
| Unknown vegetation type estimate | 20 or 30* | |
| Unknown pile estimate | 10 | |
| “Light fuels” estimate | 10 | |

* Prior to 2010, an emission factor of “30” was used for unknown vegetation type. Since then, an emission factor of either “20” or “30” has been used depending upon location (i.e., predominant vegetation type) of the fire. Fires located in the SWS or GAD were estimated to have an emission factor of “20,” the rest were estimated as “30.” Overall, only a small percentage of fires did not list at least one vegetative type that could be used for an emission factor.

[7] 2005 Alaska Wildland Fire Emissions Inventory and Wildland Fire Emissions Inventory Template, prepared by Air Sciences, Inc., for the Alaska Department of Environmental Conservation, project no. 217-2, June 2007, section 1.4.
[8] estimate “low” as only grass/slash understory may burn

## A.2. 2013 Individual vegetation types for the 20 LANDFIRE wildfires

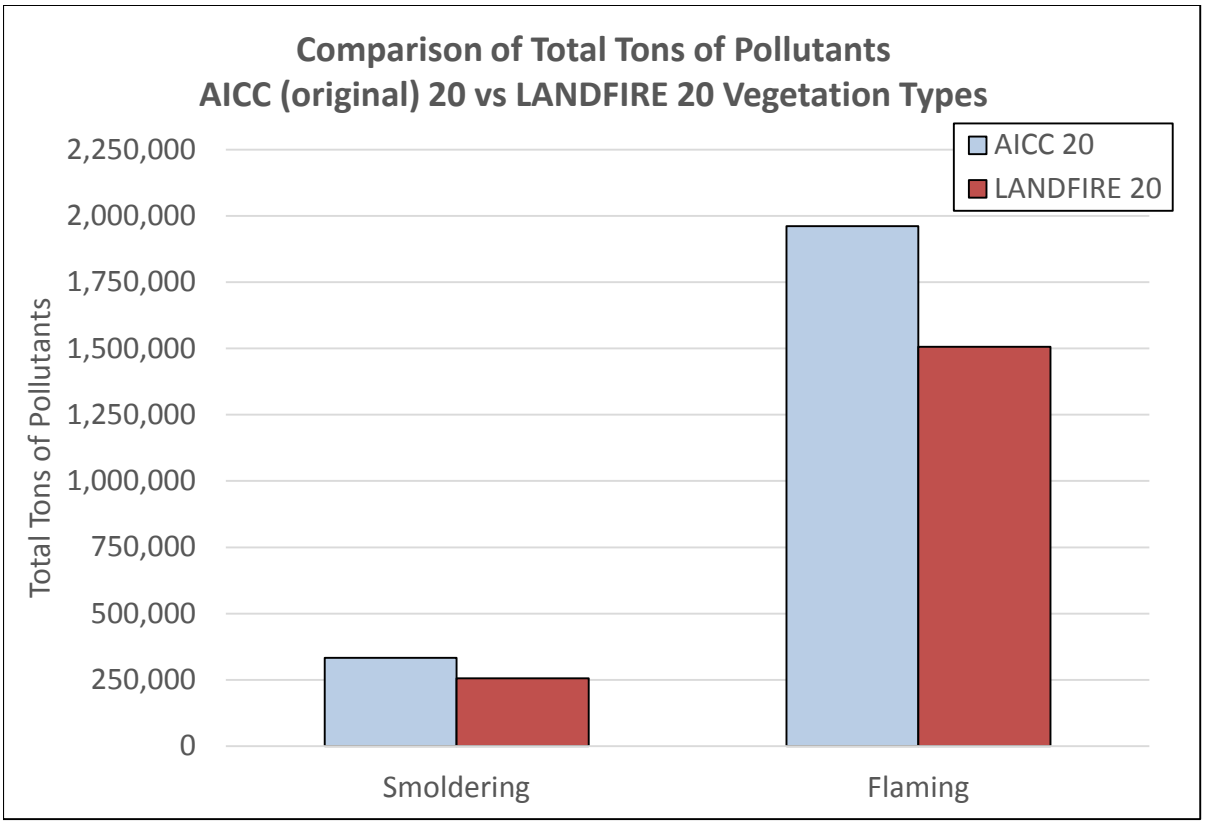
| LANDFIRE # | Existing Vegetation Type Name | Emission Factor | Vegetation Type Group |
|---|---|---|---|
| 11 | Open Water | 0 | Open Water |
| **12** | **Snow-Ice** | **0** | **Barren** |
| **22** | **Developed-Low Intensity** | **0** | **No Dominant Lifeform** |
| 31 | Barren | 0 | Barren |
| **82** | **Agriculture-Cultivated Crops and Irrigated Agriculture** | **1** | **Herbaceous - grassland** |
| **2197** | **Recently Burned-Tree Cover** | **20** | **Open tree canopy** |
| 2600 | Western North American Boreal White Spruce Forest | 30.35 | White Spruce Forest and Woodland |
| 2601 | Western North American Boreal Treeline White Spruce Woodland | 30.35 | White Spruce Forest and Woodland |
| 2602 | Western North American Boreal Spruce-Lichen Woodland | 34.785 | Spruce-Lichen Woodland |
| 2603 | Western North American Boreal White Spruce-Hardwood Forest | 44 | White Spruce-Hardwood Forest & Woodland |
| 2604 | Western North American Boreal Mesic Black Spruce Forest | 57.57 | Black Spruce Forest and Woodland |
| 2605 | Western North American Boreal Mesic Birch-Aspen Forest | 30.35 | Birch-Aspen Forest |
| 2606 | Western North American Boreal Dry Aspen-Steppe Bluff | 30.35 | Dry Aspen-Steppe Bluff |
| 2607 | Western North Am. Boreal Subalpine Balsam Poplar-Aspen Woodland | 30.35 | Balsam Poplar-Aspen Woodland |
| 2609 | Alaska Sub-boreal Mesic Subalpine Alder Shrubland | 8 | Alder Shrubland |
| 2610 | Western North American Boreal Mesic Scrub Birch-Willow Shrubland | 8 | Willow Shrubland |
| 2611 | Western North American Sub-boreal Mesic Bluejoint Meadow | 0.75 | Wet Meadow |
| 2612 | Western North American Boreal Dry Grassland | 0.75 | Boreal Grassland |
| 2631 | Western North American Boreal Alpine Dwarf-Shrub Summit | 8 | Dwarf Shrubland |
| **2633** | **Western North American Boreal Alpine Mesic Herbaceous Meadow** | **0.75** | **Herbaceous - forbland** |
| 2634 | Western North American Boreal Alpine Dryas Dwarf-Shrubland | 8 | Dwarf Shrubland |
| 2635 | Western North American Boreal Alpine Ericaceous Dwarf-Shrubland | 8 | Dwarf Shrubland |
| 2636 | Western North American Boreal Alpine Dwarf-Shrub-Lichen Shrubland | 8 | Dwarf Shrubland |
| **2643** | **Alaskan Pacific Maritime Alpine Dwarf-Shrubland** | **8** | **Herbaceous - Shrub Steppe** |
| **2645** | **Alaska Sub-boreal and Maritime Alpine Mesic Herbaceous Meadow** | **0.75** | **Herbaceous - forbland** |
| 2677 | Alaska Sub-boreal White-Lutz Spruce Forest and Woodland | 30.35 | White Spruce Forest and Woodland |
| 2679 | Alaska Sub-boreal White Spruce-Hardwood Forest | 44 | White Spruce-Hardwood Forest & Woodland |
| 2682 | Alaska Arctic Scrub Birch-Ericaceous Shrubland | 8 | Dwarf Shrubland |
| 2690 | Alaska Arctic Dwarf-Shrubland | 8 | Dwarf Shrubland |
| 2691 | Alaska Arctic Acidic Dwarf-Shrub Lichen Tundra | 13.5 | Shrub Tundra |
| 2692 | Alaska Arctic Non-Acidic Dwarf-Shrub Lichen Tundra | 13.5 | Shrub Tundra |
| 2699 | Alaska Arctic Mesic Herbaceous Meadow | 0.75 | Herbaceous Meadow |
| 2740 | Boreal Aquatic Beds | 0.75 | Freshwater Aquatic Bed |
| 2744 | Arctic Herbaceous Wetlands | 0.75 | Freshwater Marsh |
| 2745 | Boreal Herbaceous Wetlands | 0.75 | Wet Meadow |
| 2747 | Arctic Sedge Meadows | 0.75 | Wet Meadow |
| 2751 | Boreal Coniferous Woody Wetland | 34.5 | Peatland Forests |
| 2753 | Boreal Coniferous-Deciduous Woody Wetland | 57.57 | Black Spruce Forest and Woodland |
| 2757 | Boreal Dwarf Shrub Wetland | 8 | Dwarf Shrubland |
| 2762 | Arctic Floodplains | 15 | Floodplain Forest and Shrubland |
| 2763 | Boreal Floodplains | 15 | Floodplain Forest and Shrubland |
| 2772 | Arctic Peatlands | 15 | Shrub and Herbaceous Peatlands |
| 2773 | Boreal Peatlands | 15 | Shrub and Herbaceous Peatlands |
| 2776 | Boreal Riparian Stringer Forest and Shrubland | 30.35 | Riparian Stringer Forest and Shrubland |
| 2777 | Boreal Shrub Swamp | 8 | Shrub Swamp |
| 2782 | Boreal Tussock Tundra | 8.5 | Tussock Tundra |
| 2784 | Arctic Shrub-Tussock Tundra | 8.5 | Tussock Tundra |
| 2786 | Boreal Shrub-Tussock Tundra | 8.5 | Tussock Tundra |
| 2793 | Boreal Sparsely Vegetated | 0 | Bedrock, Scree, and Talus |

Note: **Bold** indicates new emission factors for 2013

## A.3. Comparison between the AICC and LANDFIRE vegetation types and total calculated emissions.

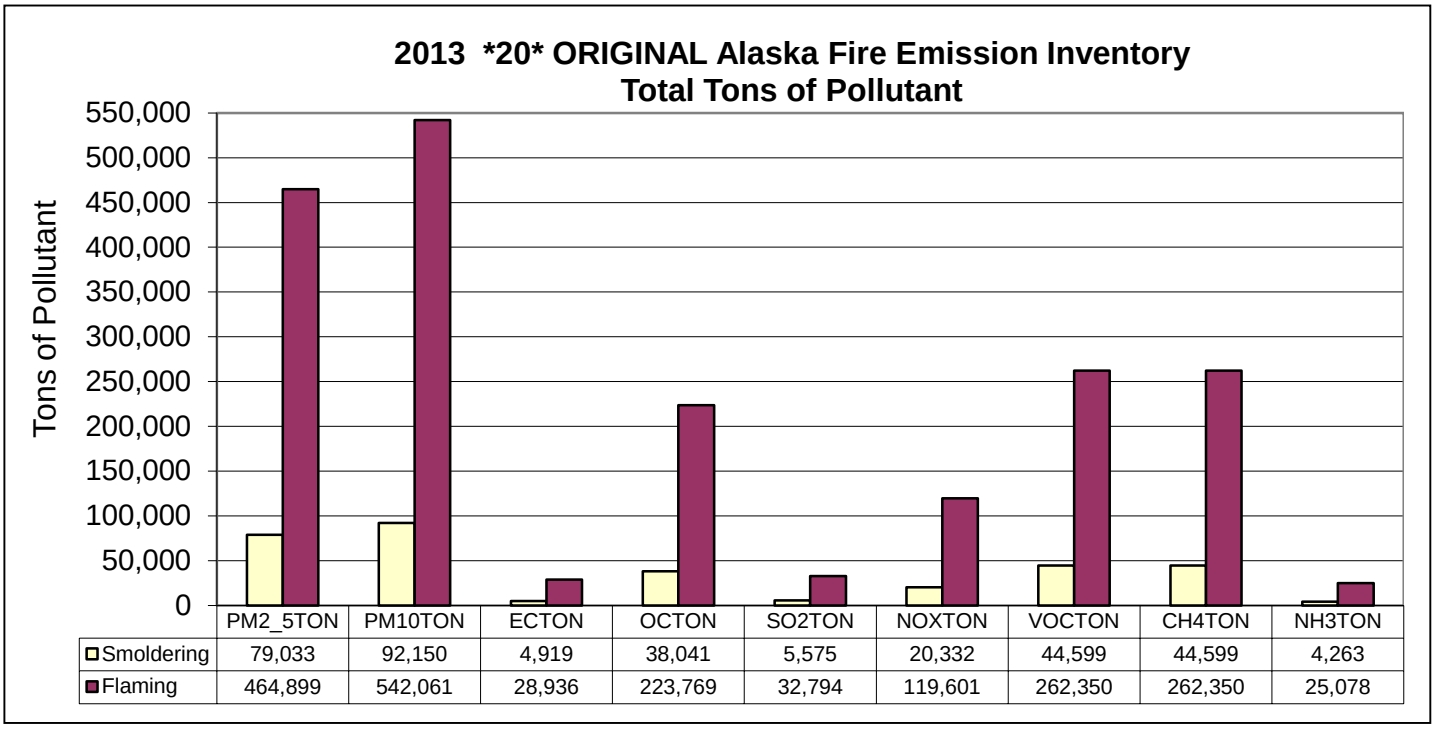
The following graph shows the difference between the "AICC" vegetation type total smoldering and flaming pollutant levels and the "LANDFIRE" vegetation type pollution levels for the 20 largest fires. As in 2012, use of LANDFIRE EF in 2013 showed lower emissions than the AICC EF because the LANDFIRE vegetation types reported had lower emission factors than the AICC vegetation types. The relationship may be different in future years. Use of LANDFIRE is considered to be more accurate since the vegetative types were determined post-burn instead of the first day of the burn.

Overall emissions in 2013 for the 20 fires were calculated to be approximately 23% lower with the use of LANDFIRE vegetation types.

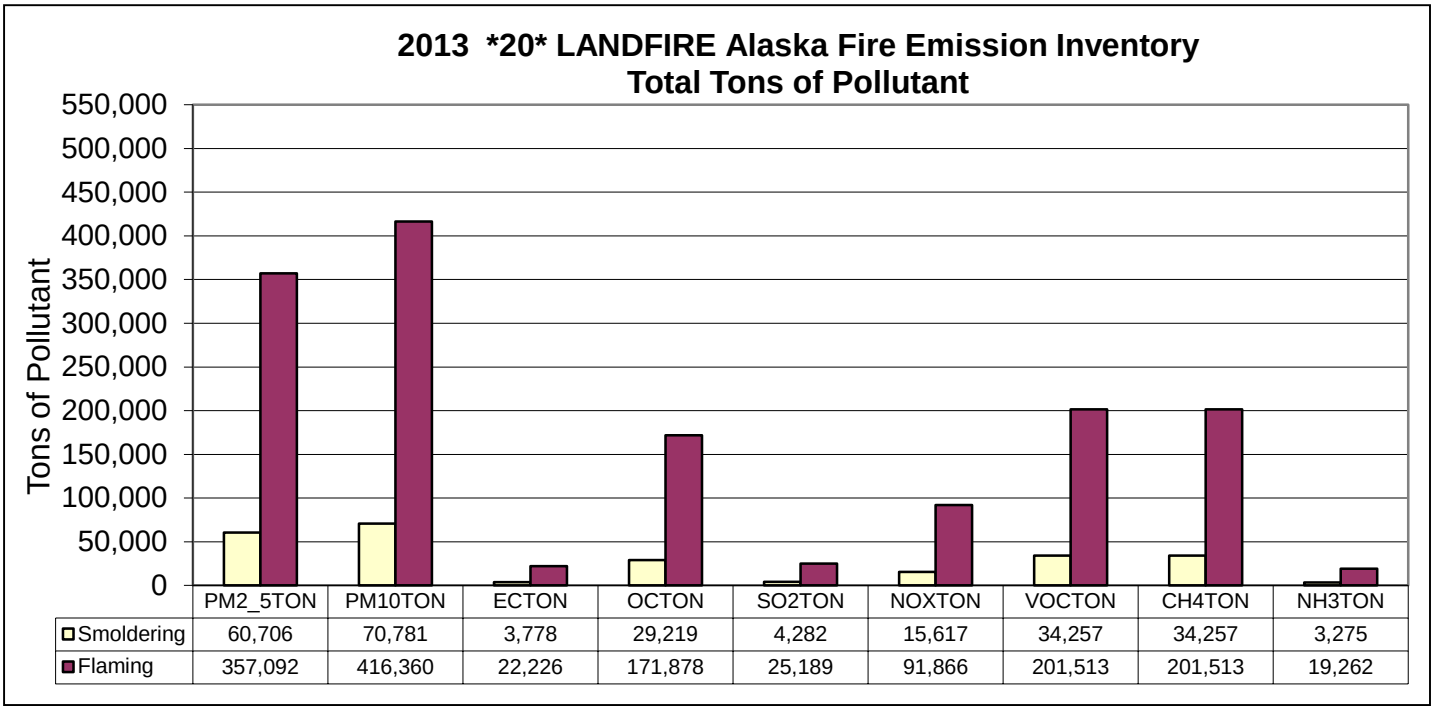


**A.4. Comparison between the AICC and LANDFIRE vegetation types and specific calculated emissions.**

The following graphs show the difference between the "AICC" vegetation type pollutant levels and the "LANDFIRE" vegetation type pollution levels for the 20 largest fires. As noted previously, in 2013, use of LANDFIRE EF showed lower emissions than the AICC EF. Use of LANDFIRE is considered to be more accurate since the vegetative types were determined post-burn instead of the first day of the burn. Individual calculated pollutant emissions in 2013 for the 20 fires were also approximately 23% lower with the use of LANDFIRE vegetation types.



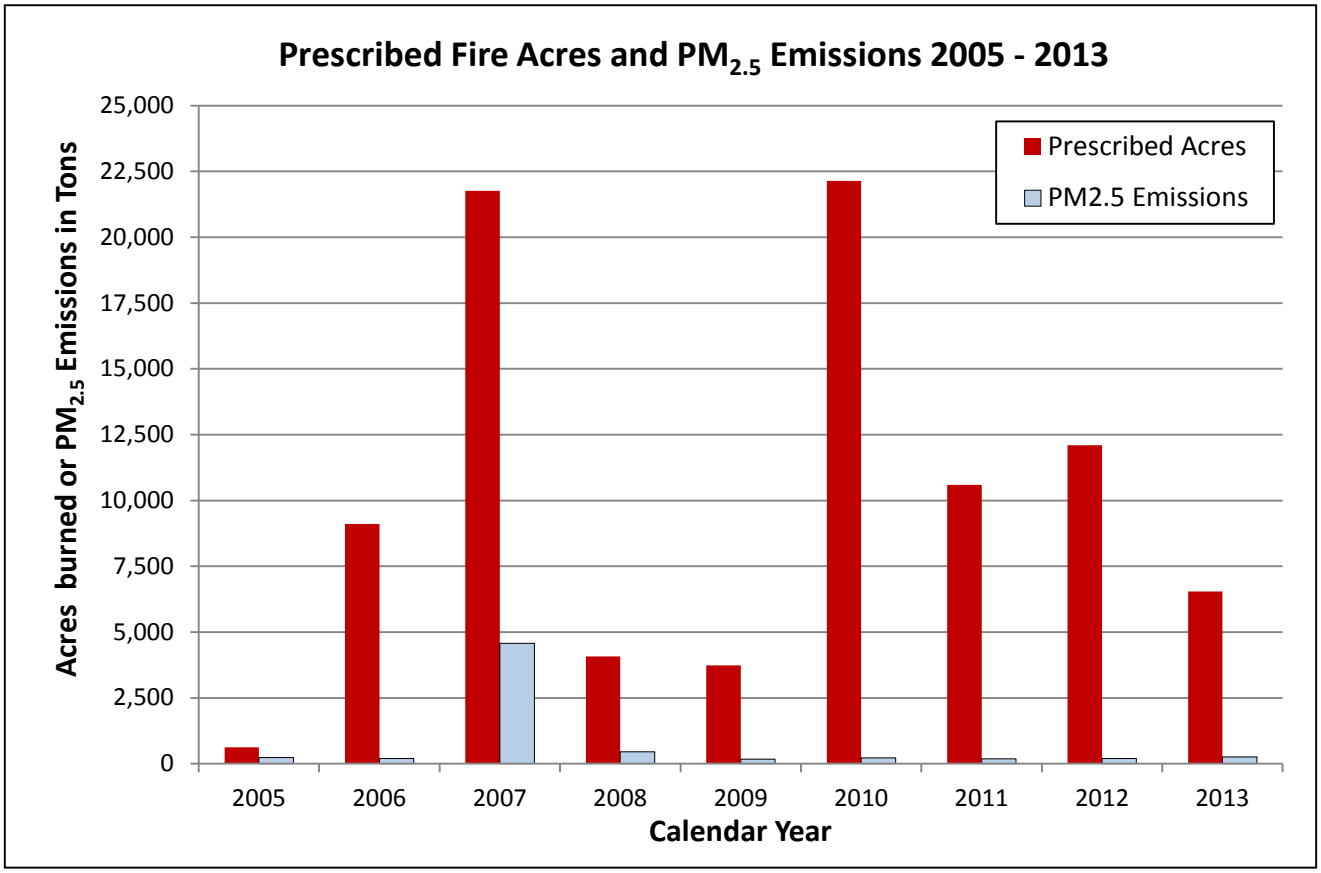

| | PM2_5TON | PM10TON | ECTON | OCTON | SO2TON | NOXTON | VOCTON | CH4TON | NH3TON |
|---|---|---|---|---|---|---|---|---|---|
| Smoldering | 79,033 | 92,150 | 4,919 | 38,041 | 5,575 | 20,332 | 44,599 | 44,599 | 4,263 |
| Flaming | 464,899 | 542,061 | 28,936 | 223,769 | 32,794 | 119,601 | 262,350 | 262,350 | 25,078 |




| | PM2_5TON | PM10TON | ECTON | OCTON | SO2TON | NOXTON | VOCTON | CH4TON | NH3TON |
|---|---|---|---|---|---|---|---|---|---|
| Smoldering | 60,706 | 70,781 | 3,778 | 29,219 | 4,282 | 15,617 | 34,257 | 34,257 | 3,275 |
| Flaming | 357,092 | 416,360 | 22,226 | 171,878 | 25,189 | 91,866 | 201,513 | 201,513 | 19,262 |

## B. Comparison of Yearly Prescribed Burn Acres and Emissions

The graph below shows nine years of acreage burned and $PM_{2.5}$ emissions from prescribed fire for the years 2005 through 2013.



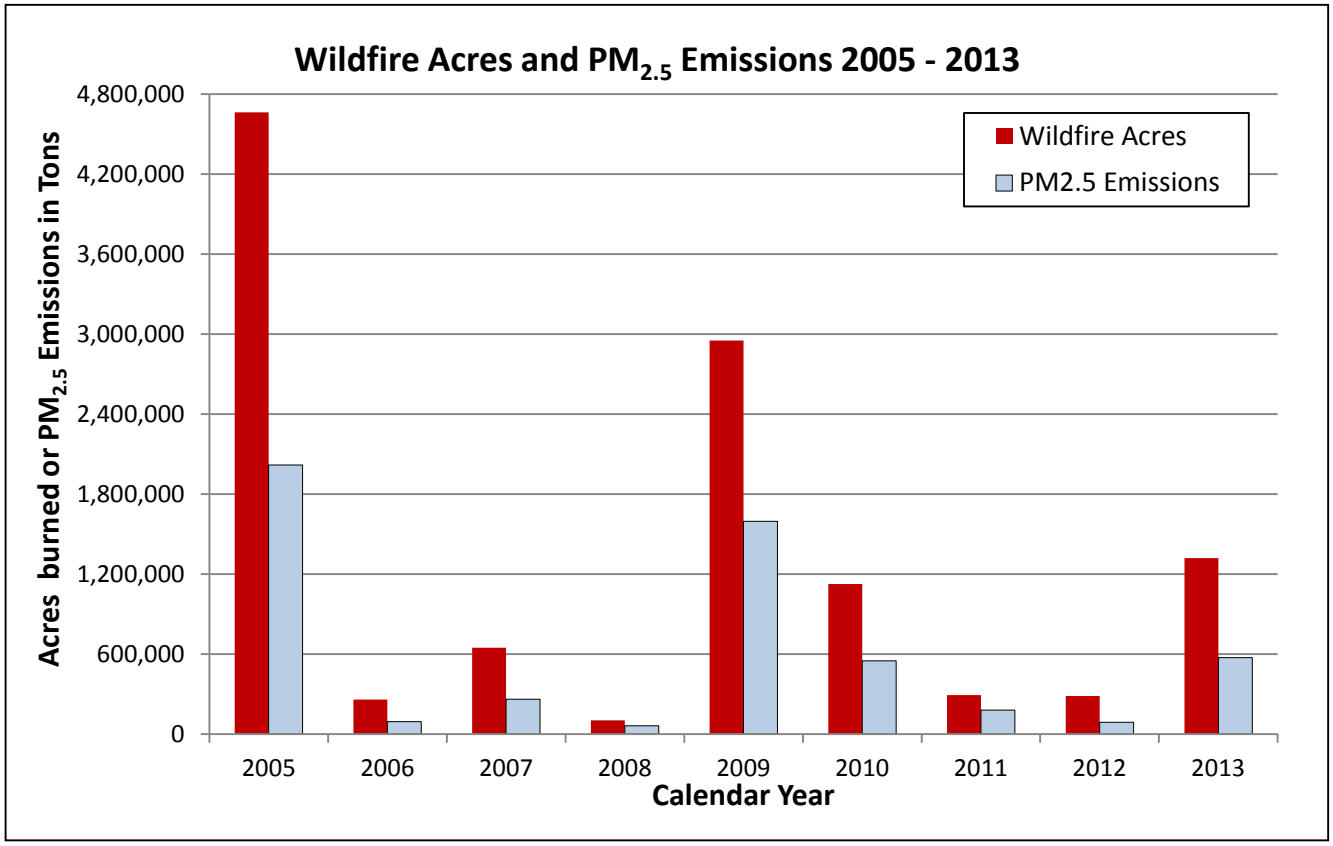

Graph details are below:

| Calendar Year | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 |
|---|---|---|---|---|---|---|---|---|---|
| Acres | 626 | 9,110 | 21,761 | 4,081 | 3,740 | 22,136 | 10,585 | 12,095 | 6,549 |
| Tons $PM_{2.5}$ | 231 | 200 | 4570 * | 454 | 172 | 227 | 189 | 193 | 260 |

* In 2012, the tons $PM_{2.5}$ for 2007 were revised downward from the previous total of 8,230 tons due to re-calculating with a lower emission factor for one fire, Oklahoma Range. No vegetation types had been listed in the AICC daily report, so a value of "30," for unknown vegetation type, was originally used. The original value appeared high compared to other years, and after further research the vegetation types were found and the emission factor was calculated to be 16.

## C. Comparison of Yearly Wildfire Acres and Emissions

The yearly wildfire acreage burned and $PM_{2.5}$ emissions for the past nine years are shown on the graph below.

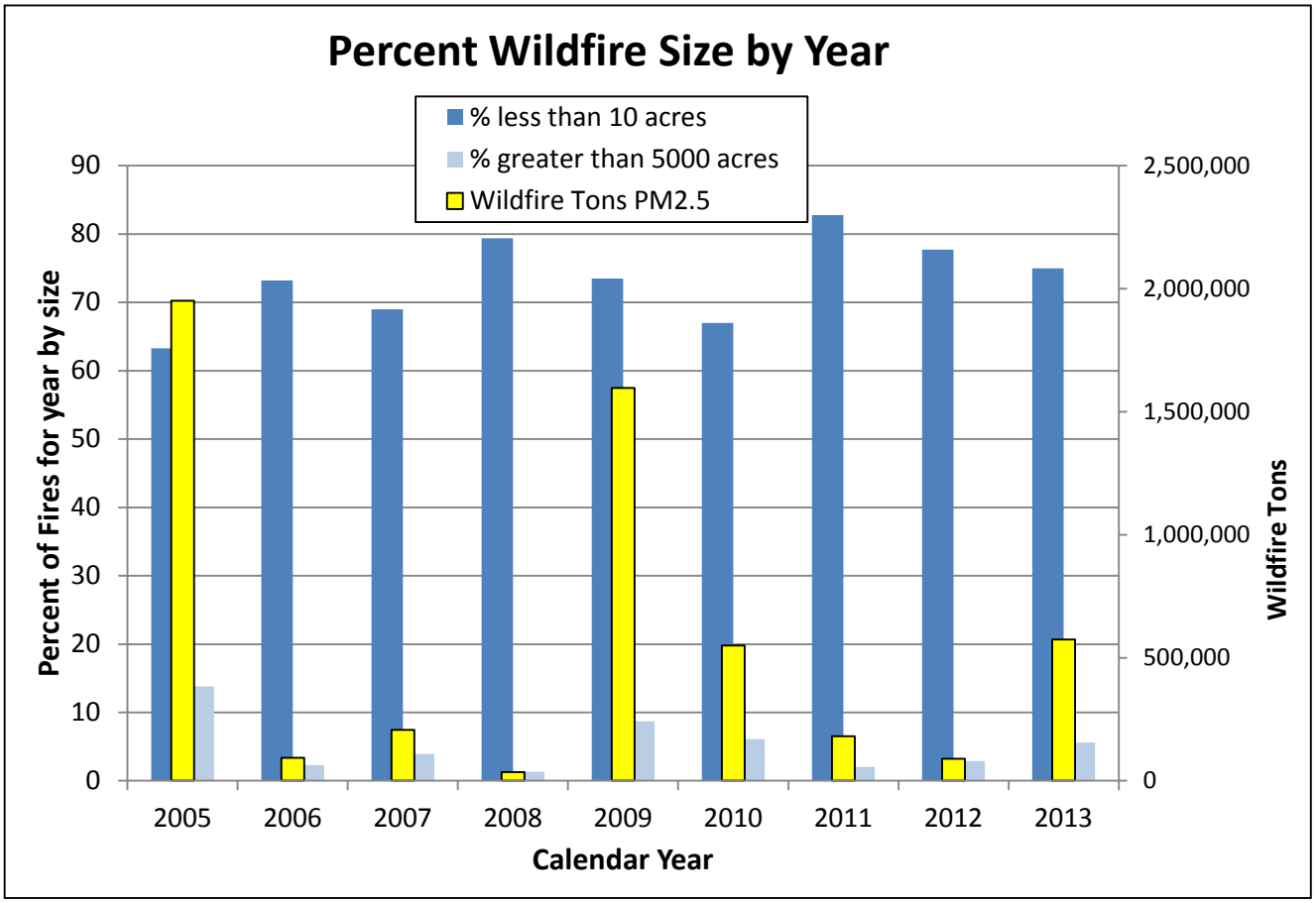



| Calendar Year | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 |
|---|---|---|---|---|---|---|---|---|---|
| Wildfire Acres | 4,493,846 | 258,529 | 536,180 | 62,650 | 2,951,598 | 1,125,499 | 293,018 | 286,888 | 1,320,748 |
| Wildfire Tons $PM_{2.5}$ | 1,951,531 | 93,409 | 207,428 | 35,785 | 1,597,149 | 549,494 | 180,976 | 89,560 | 574,496 |
| Wildland[9] Fire Use Acres | 169,956 | 1,613 | 113,235 | 40,999 | N/A | N/A | N/A | N/A | N/A |
| Wildland Fire Use Tons $PM_{2.5}$ | 67,353 | 40 | 54,232 | 27,091 | N/A | N/A | N/A | N/A | N/A |

[9] The Wildland Fire Use category acreage was added to the wildfire acreage for years 2005 through 2008 for consistency in the graph. The category was discontinued after 2008.

### D. Percent Wildfires by size by year compared to Tons PM2.5 per year

The number of small fires (less than 10 acres) and the number of larger fires (5000 acres or larger) is compared to the Total Tons Wildfire PM2.5 produced per year as shown below. The data seems to indicate the larger the acreage of large fires (over 5000 acres) the greater the amount of emissions produced. The number of small fires (10 acres or less) does not seem to have much effect on total emissions.




Numeric details for the above graph:

| Calendar Year | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 |
|---|---|---|---|---|---|---|---|---|---|
| % less than 10 acres | 63.3 | 73.2 | 69 | 79.4 | 73.5 | 67 | 82.8 | 77.7 | 75.0 |
| % greater than 5000 acres | 13.8 | 2.3 | 3.9 | 1.3 | 8.7 | 6.1 | 2.0 | 2.9 | 5.6 |
| Wildfire Tons $PM_{2.5}$ | 1,951,531 | 93,409 | 207,428 | 35,785 | 1,597,149 | 549,494 | 180,976 | 89,560 | 574,496 |