Columbia River Gorge Air Quality Study Emission Inventory Report

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I. Background

The Emission Inventory (EI) work is part of the Gorge Air Quality Study, which is designed to provide an assessment of the causes of visibility impairment in and around the Columbia River Gorge National Scenic Area (Scenic Area). There are three key ways we learn about AQ: through monitoring, modeling and emission inventory. This document is a high level summary describing what an EI is, how it fits into the Gorge technical study, and provides information on sources and pollutants that contribute to air quality in the Gorge.

II. Purpose of an Emission Inventory

An emissions inventory is important for a number of reasons. An emission inventory is an itemized list of emission estimates for sources of air pollution in a given area for a specified time period (annual and seasonal emissions). The emissions calculated for an emission inventory do not correlate to ambient concentrations found in the environment. The role of the inventory is to identify the estimated amount of each pollutant from various source types. For example, emissions are broken down into source categories, and for each source category the emissions are calculated using prescribed methodologies. Based on the types and amounts of emissions the EI can be used to develop an understanding of the sources that may impact the Scenic Area. Sources are either man-made or natural sources. The EI includes emissions from point sources (e.g., industry), mobile sources (e.g., motor vehicles, ships, trains, and aircraft), area sources (e.g., woodstoves, outdoor burning, paint and solvent use, and small, non-permitted point sources), and natural sources (e.g., emissions from sources such as vegetation and volcanic activity).

The emissions inventory is also used to conduct air dispersion and chemical transport modeling. Air dispersion modeling is a way to show the transport of ambient air pollutants. By using information such as meteorology and an emissions inventory, computer models can calculate ambient pollutant concentrations in the air. The air dispersion model is considered to be performing well when it can simulate actual monitored air concentrations that have already occurred. The better a model simulates the past, the better the confidence of predicting future-year scenarios and any resulting strategy development. Additionally, because of the complex chemistry, meteorology, and air movement that occurs in the Gorge area, there are a number of different factors that can translate emissions into air quality impacts. As such, judging any source category's contribution to impairment requires that we evaluate emissions, their chemical transformation and meteorological conditions.

One other purpose of an emission inventory is to provide an estimate of future air quality. Future year inventories are calculated using growth assumptions. Depending on the category, emissions will either increase or decrease based on estimated changes in indicators such as population, economic and industrial activity, and vehicle traffic. The EI is a catalog of the best estimate of current emissions, and a good prediction of what is likely to happen in the future. Both present and future year inventories are critical components of air quality modeling and planning.

III. How was the Gorge EI Developed?

A. Calculating Emissions for an Inventory

In compiling the emissions for an emission inventory, source categories are identified and emissions are calculated using specific methodologies. For point sources, emission characteristics of individual industrial facilities vary widely depending on the type of processes at each facility and can be calculated using generalized or specific emission factors. Area sources can include groups of numerous small point sources, such as dry cleaners or non-permitted small sources which individually do not emit significant amounts of pollutants but when combined can contribute to the emission inventory. Emissions from these sources are grouped into categories and calculated based on county or state estimates. Many area source categories are further classified into subcategories for better emission computation, specification, and future-year projections. For example surface coating categories can be subdivided into various types of coatings and varnishes to account for varying solvent content. On-road emissions are calculated using computer models. For other mobile sources various methodologies such as emission factors from EPA are used to estimate emissions from these sources. Pollutants from natural sources such as vegetation, wildfires, and volcanic activity are oftentimes a significant part of the emission inventory. Vegetation for example, emits large amounts of volatile organic compounds (VOC), which are precursors of ozone. While VOC emissions can contribute to the formation of ozone, the primary pollutants impacting visibility in the Gorge are organic carbon (a component of PM2.5), nitrates, and sulfates. These pollutants all have the ability to either scatter or absorb light, both of which affect visibility.

B. Emission Inventories Used in the Gorge EI

i. U.S. EPA - National Emissions Inventory (NEI)

Emissions inventories have been critical for the efforts of state, local and federal agencies to attain and maintain the National Ambient Air Quality Standards (NAAQS) that EPA has established for criteria pollutants such as ozone, particulate matter, and carbon monoxide. In the past, mobile, area and biogenic emission inventories have been completed as needed to support activities such as nonattainment/maintenance planning efforts or as time and resources allowed. Point source inventories have been developed each year by the state and local agencies and submitted to EPA for major sources annually. Beginning in 1999 state and local agencies were required to submit emissions information to EPA as part of the National Emissions Inventory (NEI). These emission inventories include information about point, area, on-road mobile, nonroad, and natural sources. EPA compiles the information and adds emissions category data that may not have been submitted by the states, such as fugitive dust. Agencies then review and comment on the revised inventory, EPA makes further revisions, and a final NEI is made available for use. The most current inventory data available was used for modeling and haze assessment purposes for the Scenic Area.

ii. WRAP EI

The Western Regional Air Partnership (WRAP) is an organization composed of state, federal, and tribal governments formed to address the federal regional haze rules and other air quality issues in the western U.S. The air quality agencies in Oregon and Washington participate regularly in the Emissions Forum of the WRAP. WRAP developed an emissions inventory for the 14 Western states based on EPA's final 2002 NEI, and used it as the WRAP 2002 "base year" inventory from which it projected future year emissions for 2008, 2013, and 2018 for regional haze purposes.

C. Gorge Project EI

To run an air dispersion model, specific timeframes must be selected in order to create and compare modeling output information to observed monitoring results. This helps create a "base case" modeling output to confirm that the "base case" scenario simulates actual monitored air concentration values that have already occurred. While the model output is not always used to compare estimated model concentrations to actual monitoring values, it can be used in a relative sense. If the modeling concentrations show fluctuations during an episode, these fluctuations should be reflected in the monitoring data. Therefore, trends in the EI should for the most part corroborate the trends shown in the modeling and monitoring data. The better a model simulates the past (base case) monitoring data, the better the confidence of predicting future-year scenarios.

The Gorge Technical Team decided that air quality monitoring would take place from July 2003 through February 2005. The team selected 2004 as the "base year" because the emissions information could be input to a model and the output concentrations compared to actual 2004 monitoring data collected in the Gorge. The "base-year" emissions inventory was created to document actual emissions that occurred in the airshed. For the "future year" comparison, the Team selected 2018 because the WRAP EI was already projected to that year. It allowed for the Gorge modeling to tie in with the WRAP regional modeling for visibility and regional haze.

The Gorge Technical Team reviewed the collected monitoring data. Two summertime (July and August 2004) and two wintertime (Feb 2004 and Nov. 2004) episodes were initially identified for further study based on the monitoring data and analysis presented in the Columbia River Gorge Haze Gradient Study and Causes of Haze in the Gorge (CoHaGo) reports. Because of limited funding, only one wintertime and one summertime episode could be modeled. August and November 2004 were chosen because of the greatest visibility impairment and emissions inventory availability. For EI analysis and this document, two specific days, August 18 and November 12, were chosen from the summertime and wintertime episodes for each year to provide a snapshot of the emission inventory. During the analysis, the team learned that the PGE Boardman plant was shut down on November 9th and 10th, prompting the selection of November 12th for data analysis.

i. Creating the 2004 EI

Using the 2002 NEI as the foundation, Oregon and Washington provided 2004 annual emissions data for point sources as these sources are required to report their emissions each year. For the area sources and nonroad sources such as locomotives, aircraft, and marine vessels, Oregon and Washington grew 2002 NEI emissions to 2004. Growth factors for population, housing units, and employment were developed from *"Economic Report to the Metro Council, 2000-2030 Regional Forecast for the Portland-Vancouver Metropolitan Area"*, a Metro report prepared in September 2002. The 2004 VMT was derived from ODOT projections of future year travel provided to DEQ via e-mail. For all other nonroad vehicles and equipment Oregon and Washington ran the EPA NONROAD2005 model to generate daily emissions. Information on the basis and methodology for the emissions growth process from 2002 to 2004 is detailed in the <u>2004 Gorge Emissions Inventory for Modeling</u> report (DEQ, 2006).

To make comparisons for the episode days, the inputs for the model had to be specific to the episode. Since most of the emissions were calculated on an annual basis, these emissions needed to be adjusted to reflect seasonal, daily, and hourly rates to convert the data to the resolution needed by the model. To conduct the model to monitoring analysis, the inputs for the model had to be specific to each episode day. As such, Alpine Geophysics processed the annual emissions estimates using a software package called SMOKE (Sparse Matrix Operator Kernel Emissions). SMOKE distributes the emissions data to specific hours of a day, days of a month, and months of the year based on accepted time profiles of the activities that generated the emissions. For example, residential use of lawnmowers occurs more in the evening than the day during the week, but more during the weekend than the weekday, and more between May through October than in December and January. This type of "temporal profile" is established for each source of emissions in the inventory. The SMOKE processing system also uses land type (residential, forest, agricultural) to assign the emissions to certain areas of the county. For example, home heating/cooling and lawnmower use are located in residential areas and farm tractor emissions are placed in agricultural areas. These two activities allow the technical team to disperse the annual emissions estimate to in the selected August and November episodes for the purposes of examining the data sampled at the monitors and to evaluate the visibility in 2004 and 2018.

For on-road sources, ENVIRON (the modeling contractor to the air agencies) generated the daily and hourly 2004 emissions by running MOBILE6.2 within the air dispersion and chemical transport model using inputs provided by Oregon and Washington. On-road mobile emissions are typically characterized as motor vehicles. For the remaining emissions categories where the states could not provide updated 2004 inventory information, Alpine Geophysics (a modeling subcontractor to the air agencies) took the 2002 WRAP inventory and filled any data gaps by growing the emissions to 2004.

Further adjustments to the 2004 inventory were made, including the reduction of the emissions estimates from residential wood smoke and an increase to ammonia emissions from agricultural operations. The wood smoke reductions were made based upon a recommendation by Oregon DEQ with verification from the Washington Department of Ecology. The increase to ammonia emissions was the result of investigation into more recent EI methodology by Alpine Geophysics and the Oregon DEQ. For more detailed information on how the adjustments were calculated, please see the Gorge Modeling Report.

This 2004 emissions inventory was used as one of the inputs to the model - Comprehensive Air Quality Model with Extensions (CAMx). CAMx was used to simulate the pollutant concentrations during the two chosen episodes. The model is run in an iterative fashion until it represents the monitored data with a known degree of uncertainty. These uncertainty parameters are discussed in detail in the modeling report.

ii. Creating the 2018 EI

The source of the 2018 EI for the Gorge air quality study was the 2018 EI developed by WRAP. When WRAP developed the 2018 EI, it projected its 2002 base year inventory using EPA's Economic Growth and Analysis System (EGAS) growth factor, US Energy Information Administration (EIA) energy projections, and USDA agricultural projections. VMT growth assumptions for on-road mobile reflect the region's local travel forecast. The EGAS model includes population growth estimates, economic forecasts, increases in motor vehicle travel (vehicle miles traveled, or VMT). EGAS generates an EPA Source Classification Code (SCC)-specific growth factor for a specified geographic area using various socio-economic data.

The WRAP also factored in emissions reductions expected from EPA rules that had been promulgated as of December 2005. However other EPA rules, such as the Best Available Retrofit Technology (BART) rule for the BART sources (which would include PGE Boardman), did not have its expected emissions reductions factored into the 2018 inventory. Other source categories, such as emissions for wildfires and windblown dust were held constant from 2004 to 2018. Although the WRAP did revisit its 2018 inventory and provide updates to include expected emissions reductions from EPA rules (promulgated as of March 2007) and BART controls, this inventory was not completed until June 2007. Because the Gorge Technical Team needed to compile the Gorge 2018 inventory prior to the WRAP's latest update, the Gorge 2018 EI reflects information from the best available WRAP 2018 inventory estimate. For a detailed description of how WRAP grew the emissions inventory including how the EGAS model was applied to the growth factors, please refer to the WRAP Point and Area Source Emissions Projections for the 2018 Base Case Inventory (January 2006).

Additional adjustments were made to the 2018 WRAP inventory to incorporate expected impacts from EPA rules (including BART) that had been promulgated since WRAP developed its 2018 inventory. Alpine Geophysics also corrected the WRAP 2018 inventory to make it more consistent with local conditions. The Gorge Modeling Report (2007) details the adjustments made to the 2018 inventory.

iii. Projection Anomalies for the 2018 EI

When reviewing the emission inventory for the Gorge, the Technical Team discovered a few anomalies that warranted further investigation. A closer inspection of the inventory revealed that some of the emissions projections for 2018 were inappropriately grown and at least one source was incorrectly located. The original growth projections developed by WRAP using EPA's EGAS model grew certain industrial point sources to projections that were unrealistic for local conditions and economic expectations. More specific county-level growth factors were not applied because the county level socio-economic data was not available at the time. Therefore, the EGAS model only generated growth factors at the state level, resulting in default growth factors for source categories and less specific growth information that could be applied if grown by the States. For example, the Technical Team identified an unrealistic increase in emissions from one industrial point source in the In-Gorge region. A secondary aluminum production facility was the source of the increased emissions.

Other minor inconsistencies were discovered during the EI analysis. Fugitive dust emissions were not accounted for in the East of Gorge region for 2018. An industrial source located in the West of Gorge area had its 2004 emissions incorrectly attributed to the Northwest of Gorge area. In 2018, however, its emissions were correctly attributed to location in the West of Gorge area. While each of these EI projection errors are noted in the EI report, corrections were not incorporated into the modeling due to time constraints.

iv. EI Uncertainty

In developing the Gorge EI, the Technical Team did not undertake an uncertainty analysis due to time constraints. The Team understands uncertainty exists for the Gorge EI and has not been quantified for the project. Future work on the project could include a complete EI uncertainty analysis. The EPA is currently conducting an emissions factor uncertainty assessment; information is available at:
http://www.epa.gov/ttn/chief/efpac/uncertainty.html

IV. What are the Pollutants of Concern?

A good emission inventory (EI) is necessary to understand impacts to air quality, perform source attribution, and evaluate alternative emission reduction scenarios. Each pollutant or compound has a unique set of characteristics that contribute to visibility impairment. In general, the higher the concentration of the pollutants, the more visibility is impaired. Air monitoring on bad visibility days shows the main pollutants impacting the Gorge are: organic carbon, nitrates, and sulfates. These pollutants all have the ability to affect visibility by scattering light. Sulfates and nitrates are formed from sulfur oxides (SOx) and oxides of nitrogen (NOx), which are products of fossil fuel combustion (coal burning power plants, automobiles, smelters, industrial boilers, and refineries).

Ammonia (NH_3) also plays a key role in the formation of sulfates and nitrates. Sources typically associated with ammonia emissions include livestock farming, application of fertilizer, and microbiological degradation (bacteria). For the most part, organic carbon comes from sources that emit wood smoke, such as wildfires and residential woodstoves. Another pollutant of concern is elemental carbon, a byproduct of organic carbon. Elemental carbon also affects visibility by absorbing light.

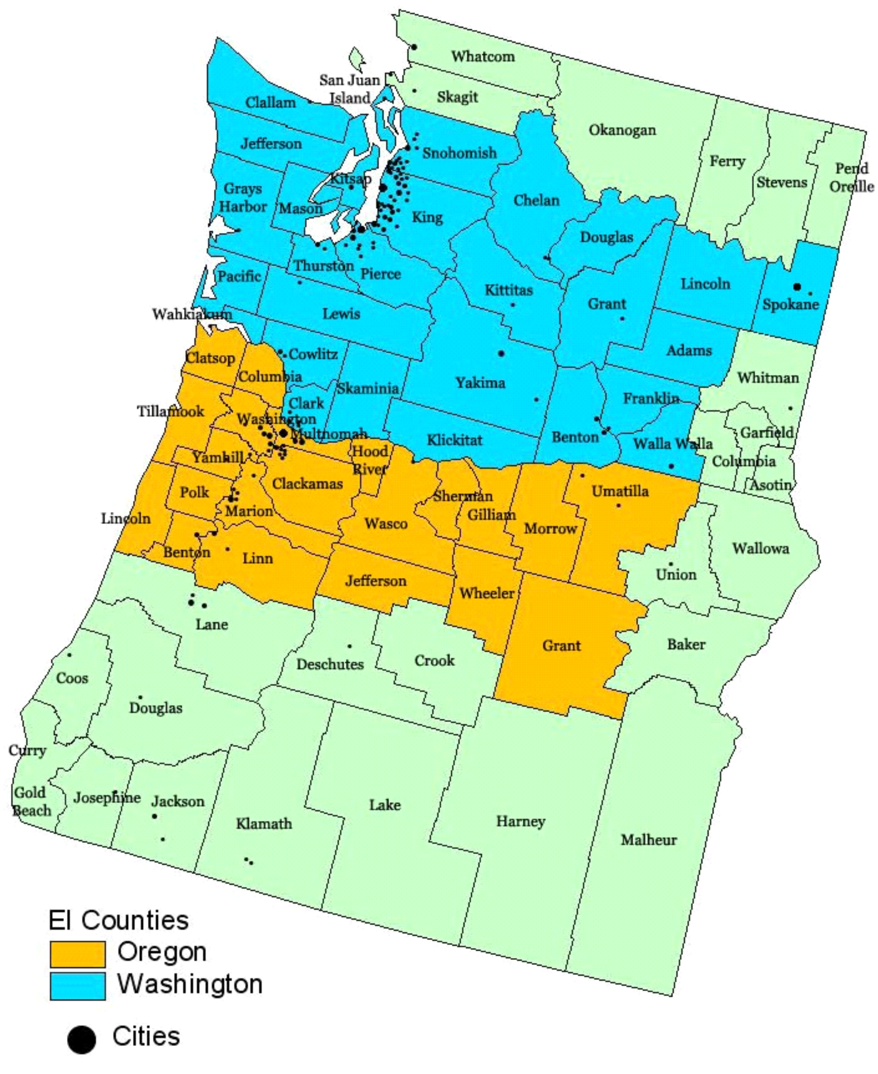
Sulfates, nitrates, and organic and elemental carbon all contribute to the formation of particulate matter; particulate matter is further defined in various sizes such as PM2.5 (particulate matter less than 2.5 microns in diameter). As such an emission inventory including SOx, NOx, NH_3, VOC, and PM2.5 was developed for the Gorge.

V. EI Areas

Based on information presented in the Causes of Haze in the Columbia Gorge Report, the long range transport of visibility impairing pollutants is in the East to West direction in the winter and the West to East direction in the summer. Emissions generated outside the 4-km modeling domain are accounted for through initial and boundary conditions emissions. CAMx employs multiple numerical algorithms that track the horizontal transport of pollutants generated outside of the EI domain. For modeling, a suitable geographic domain must be selected to characterize conditions. Once the domain is chosen, the emissions inventory is compiled for that modeling domain.

The Gorge Technical team selected a modeling domain consisting of twenty-eight counties in Washington and twenty-four counties in Oregon highlighted blue and yellow in **Figure 1**. These counties were determined to be most likely to influence visibility in the Scenic Area. The comprehensive emission inventory was developed for the modeling domain encompassing most of Washington and Oregon. This domain was divided into 4 x 4-km (6.44 mile) grids and is referred to as 4-km domain.

Figure 1: Counties Studied

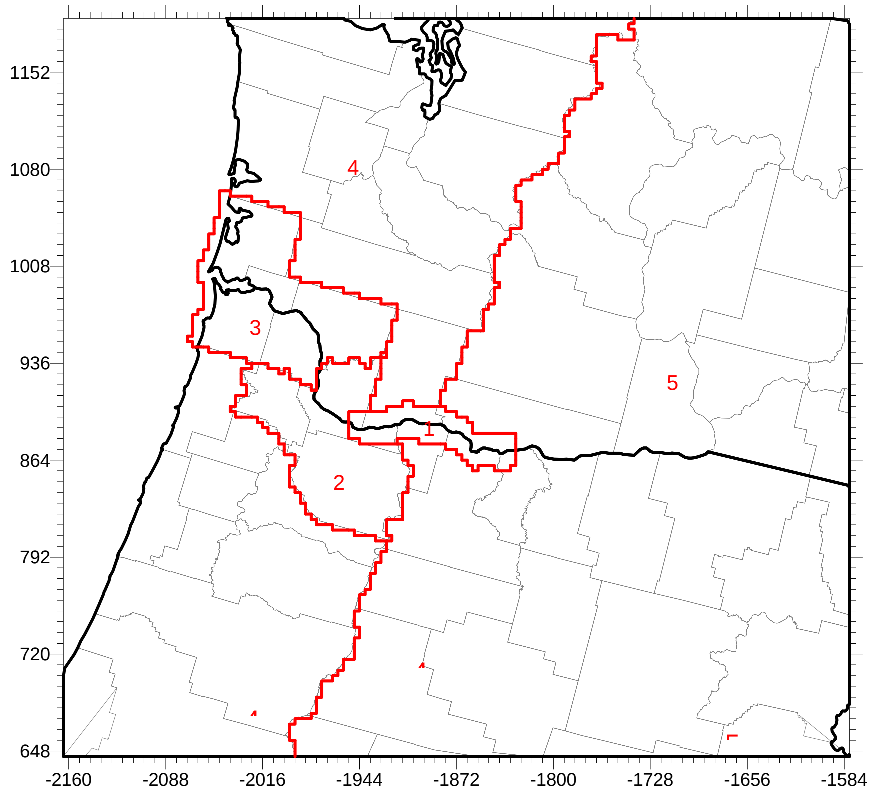


VI. Overview of Emissions by Particulate Source Apportionment Technology (PSAT) Region

In order to obtain a better understanding of source contribution from specific areas, a PSAT modeling tool was employed. The PSAT attributed sulfate, nitrate, organics, and primary particulates to regions within the Gorge. This information was used to better identify emissions within specific regions affecting the Gorge. For example, the tool provided a snapshot of the emissions coming from the Portland metropolitan area, the emissions coming from an area specifically within the Columbia River Gorge, and the contributions of these emissions.

The Technical Team divided the Gorge modeling area into 5 regions, as shown in **Figure 2**. Region 1 encompasses the Gorge Scenic Area, Region 2 - metropolitan Portland and surrounding areas, Region 3 – areas northwest of the central Gorge area, Region 4 – all other areas west of the Gorge area, and Region 5 – all other areas east of the Gorge area. Both 2004 and 2018 emissions were attributed to these areas using the PSAT modeling tool.

Figure 2: Modeling domain map of the Columbia River Gorge air quality area

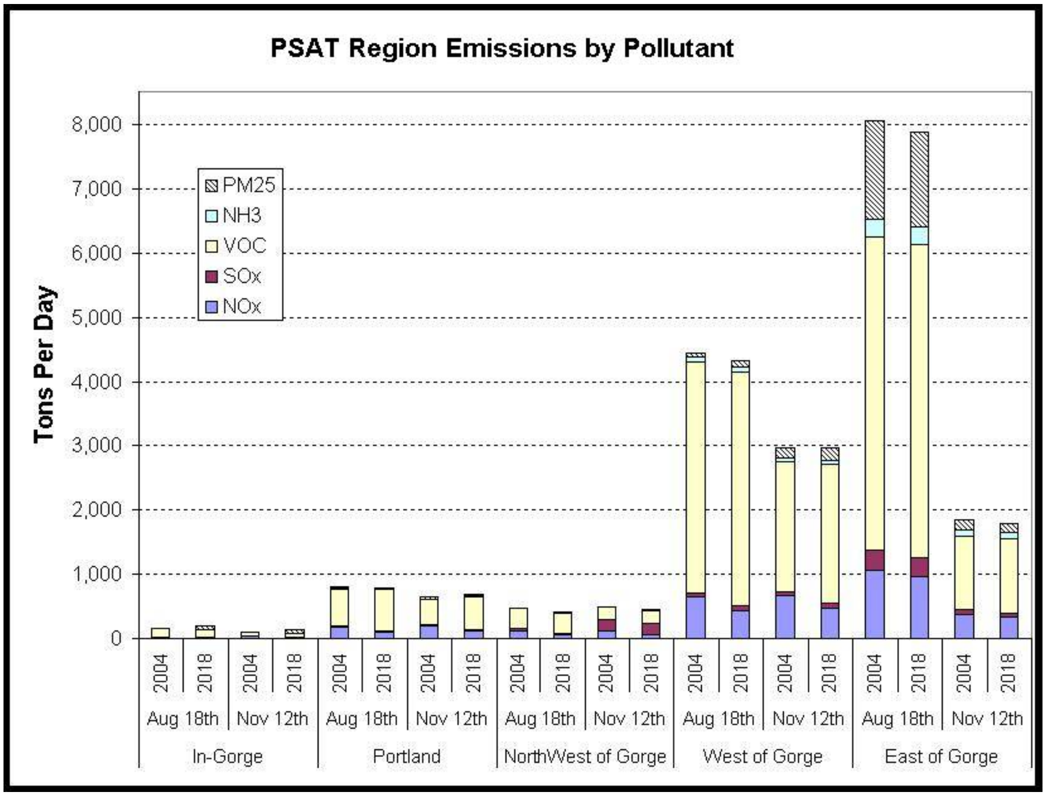


Source Region Map - 4km domain
1. In-Gorge
2. Portland
3. NorthWest of Gorge
4. West of Gorge
5. East of Gorge

(LCP Definition: -97, 40, 45, 33)

To obtain a better understanding of source contribution from the various regions in the Gorge modeling area, **Figure 3** shows the emissions by pollutant distributed amongst the five PSAT regions. Emissions from the Puget Sound area (Seattle, Tacoma, Olympia) and the Southern Willamette Valley (Salem, Eugene, Corvallis) are included in West of Gorge emissions.

Figure 3: PSAT Region Emissions by Pollutant



The contribution of pollutants from In-Gorge, Portland, and Northwest of Gorge is relatively small compared to West of Gorge and East of Gorge emissions. In particular, the In-Gorge contribution is very small in comparison to all the other regions. One reason for the significant emissions from the other areas is the larger areas that the West of Gorge and East of Gorge regions encompass.

As **Figure 3** shows, VOC emissions comprise the largest pollutant category at 5,000 tons/day. While VOC emissions contribute to the formation of ozone, the primary pollutants impacting visibility in the Gorge are organic carbon (a component of PM2.5), nitrates, and sulfates. These pollutants all have the ability to either scatter or absorb light, both of which affect visibility. PM2.5 emissions form the next highest pollutant category with 1,500 tons/day followed by NOx (1,100 tons/day).

Table 1 shows actual emissions by PSAT region. In-Gorge contribution is extremely small to the overall domain. For example, the August 18, 2004 In-Gorge source contribution is 1% (154 tons/day vs. 13,930 tons/day) of the total pollutant contribution across the entire 4-km domain. In 2018, the In-Gorge source contribution is also 1% (190 tons/day vs. 13,582 tons/day). The November In-Gorge source contribution across the entire domain is also small, comprising 2% of the total for both 2004 and 2018.

Table 1: PSAT Region Pollutant Emissions

PSAT Realm Pollutant Emissions

	Aug 18th		Nov 12th	
In-Gorge	2004	2018	2004	2018
NOx	26	19	30	23
SOx	3	2	4	3
VOC	120	119	55	56
NH3	2	2	2	2
PM25	4	48	10	51
Total	154	190	100	135
% of the Total Domain	1%	1%	2%	2%

	Aug 18th		Nov 12th	
Portland	2004	2018	2004	2018
NOx	184	99	192	111
SOx	16	21	18	25
VOC	564	640	391	506
NH3	15	16	13	14
PM25	17	15	36	37
Total	796	791	650	693
% of the Total Domain	6%	6%	11%	12%

	Aug 18th		Nov 12th	
Northwest of Gorge	2004	2018	2004	2018
NOx	111	56	109	58
SOx	43	25	190	175
VOC	309	312	181	189
NH3	5	5	4	4
PM25	9	8	14	14
Total	477	406	498	440
% of the Total Domain	3%	3%	8%	7%

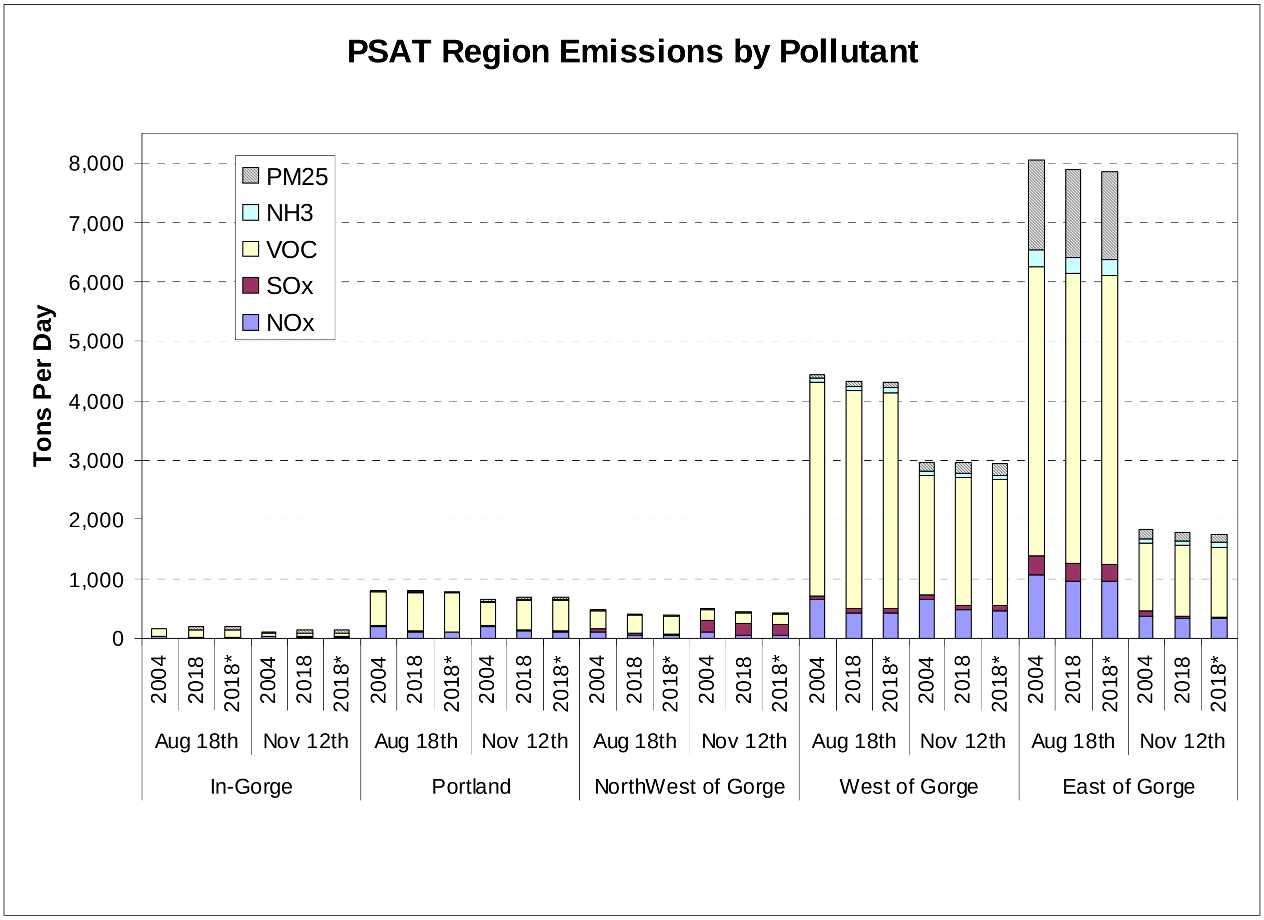
	Aug 18th		Nov 12th	
West of Gorge	2004	2018	2004	2018
NOx	656	429	659	472
SOx	47	72	58	81
VOC	3601	3654	2023	2147
NH3	77	74	65	69
PM25	65	91	153	189
Total	4446	4320	2958	2958
% of the Total Domain	32%	32%	49%	49%

	Aug 18th		Nov 12th	
East of Gorge	2004	2018	2004	2018
NOx	1068	965	382	325
SOx	313	295	75	60
VOC	4866	4871	1136	1169
NH3	280	270	85	87
PM25	1530	1474	165	137
Total	8057	7875	1843	1778
% of the Total Domain	58%	58%	30%	30%

	Aug 18th		Nov 12th	
	2004	2018	2004	2018
Total Domain Emissions	13930	13582	6049	6004

When reviewing the emission inventory for the Gorge, the Technical Team discovered a few anomalies that warranted further investigation. A closer inspection of the inventory revealed that some of the point source emissions projections for 2018 were improperly grown. While the emissions shown in **Figure 3** were used in the model, Figure 4 was compiled to show how much the overall emission contribution would change based on modified projections that would more accurately represent expected growth projections. The 2018* column in Figure 4 shows emissions adjusted for aluminum production and pulp and paper, with emissions from those industries held constant or near constant from 2004 to 2018. The original growth projections developed by WRAP (using EPA's EGAS model) grew aluminum plants and pulp and paper mills to projections that were unrealistic for local conditions and economic expectations. As shown in **Figure 4**, in comparing the 2018 modeled emissions to the adjusted 2018* emissions there is very little change from the original modeled 2018 emissions, suggesting these industrial point sources contribute a small fraction of the overall emissions, particularly when compared to natural and other man-made sources.

Figure 4: Pollutant Emissions by Region (2018 Adjusted Projections)


PSAT Region Emissions by Pollutant
Tons Per Day
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
PM25
NH3
VOC
SOx
NOx
2004
2018
2018*
Aug 18th
Nov 12th
In-Gorge
Portland
NorthWest of Gorge
West of Gorge
East of Gorge

In understanding the types of emissions being contributed to the Gorge area, **Figure 5** provides a comparison of natural and man-made sources. From the figure, the amount of natural source contribution to the Gorge is significant compared to man-made sources. With the exception of NOx, over 50% of the pollutant contribution comes from natural sources in August. The natural source contribution comes from a number of sources including vegetation (a significant component of the VOC pollutant emissions) and wildfires.

Figure 5: Natural Source vs. Man-Made Source Pollutant Contribution (Domain-Wide)

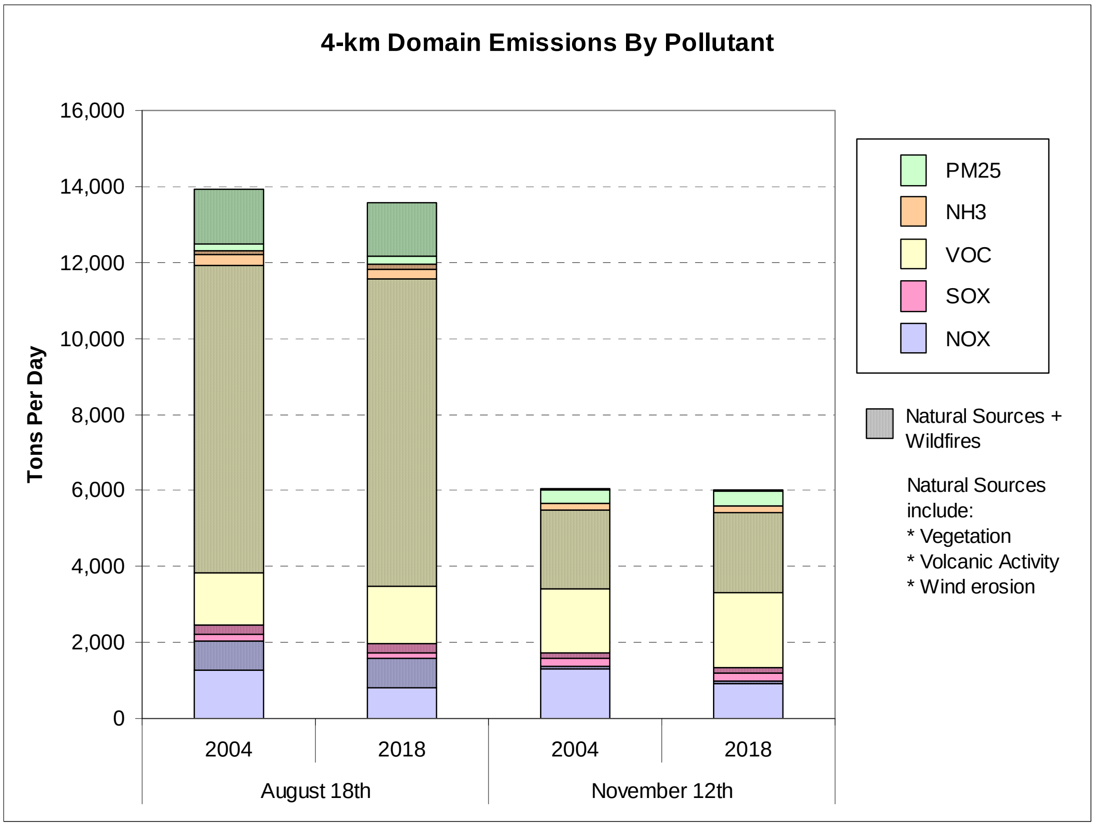


Table 2 shows the magnitude of wildfire emissions compared to non-wildfire emissions by PSAT region for August 18th, 2004. Wildfires contribute much of the SOx and PM2.5 emissions. During 2004, two major forest fires occurred within the Gorge modeling domain, but well outside the Gorge Scenic Area. Knowing how forest fires could influence emission contribution and modeling, the Gorge Technical Team specifically chose an August episode during which there was significant visibility impairment, but for which it was believed the impact from forest fires on the Scenic Area would be minimal. However, as shown in **Table 2** wildfires dominated the domain emission inventory for the chosen summer episode, particularly in the East of Gorge area where the wildfires occurred. To put forest fire emissions into perspective, wildfires emitted 81 times the amount of PM2.5 emitted by all other sources within the Portland region.

Table 2: August 18th 2004 Magnitude of Wildfire Emissions Comparison

Wildfire, Tons Per Day					
	VOC	SOX	NOX	NH3	PM25
4-km Domain	1,356	247	559	117	1,375
4 km Domain, Non-Wildfire, Tons Per Day					
Region	VOC	SOX	NOX	NH3	PM25
In-Gorge	120	3	26	2	4
Portland	564	16	184	15	17
NorthWest of Gorge	309	43	111	5	9
West of Gorge	3,596	46	653	76	60
East of Gorge	3,515	67	512	163	160
Wildfire Tons Per Day Divided by the Non-Fire Tons Per Day: Magnitude of Wildfire Emissions Compared to Non-Wildfire Emissions by Region					
Region	VOC	SOX	NOX	NH3	PM25
In-Gorge	11	98	22	56	352
Portland	2	15	3	8	81
NorthWest of Gorge	4	6	5	23	156
West of Gorge	0	5	1	2	23
East of Gorge	0	4	1	1	9

Table 3 shows the natural source contribution from volcanic activity, specifically Mt. St.

Helens, the only active volcano in the modeling domain. The only pollutant for which inventory data was available for Mt. St. Helens was SOx. SOx emissions from Mt. St. Helens fall within the Northwest of Gorge region. The contribution of SOx from Mt. St. Helens in that region is considerable, comprising 78% of the regional SOx emissions.

Table 3: Source Contribution of SOx from Volcanic Activity (Mt. St. Helens)

Natural Source Contribution - Mt.St.Helens

Mt.St.Helens, (tons/day): November 12, 2004

	VOC	SOX	NOX	NH3	PM25
4-km Domain	0	149	0	0	0

4 km Domain, (tons/day), November 12, 2004

Region	Mt.St.Helens SOx	Non-Mt.St.Helens SOx	% Contribution from Mt.St.Helens
In-Gorge	0	4	0%
Portland	0	18	0%
NorthWest of Gorge	149	41	78%
West of Gorge	0	58	0%
East of Gorge	0	75	0%

By comparing **Tables 2** and **3**, one can see that much of the emission contribution in the East of Gorge and for SOx in Northwest of Gorge comes from natural sources. In particular, the East of Gorge emissions were a significant contributor to the overall emissions when compared to the other regions. Over half of the emissions of visibility impairing pollutants such as SOx, NOx, and PM2.5 in the East of Gorge region are from natural sources.

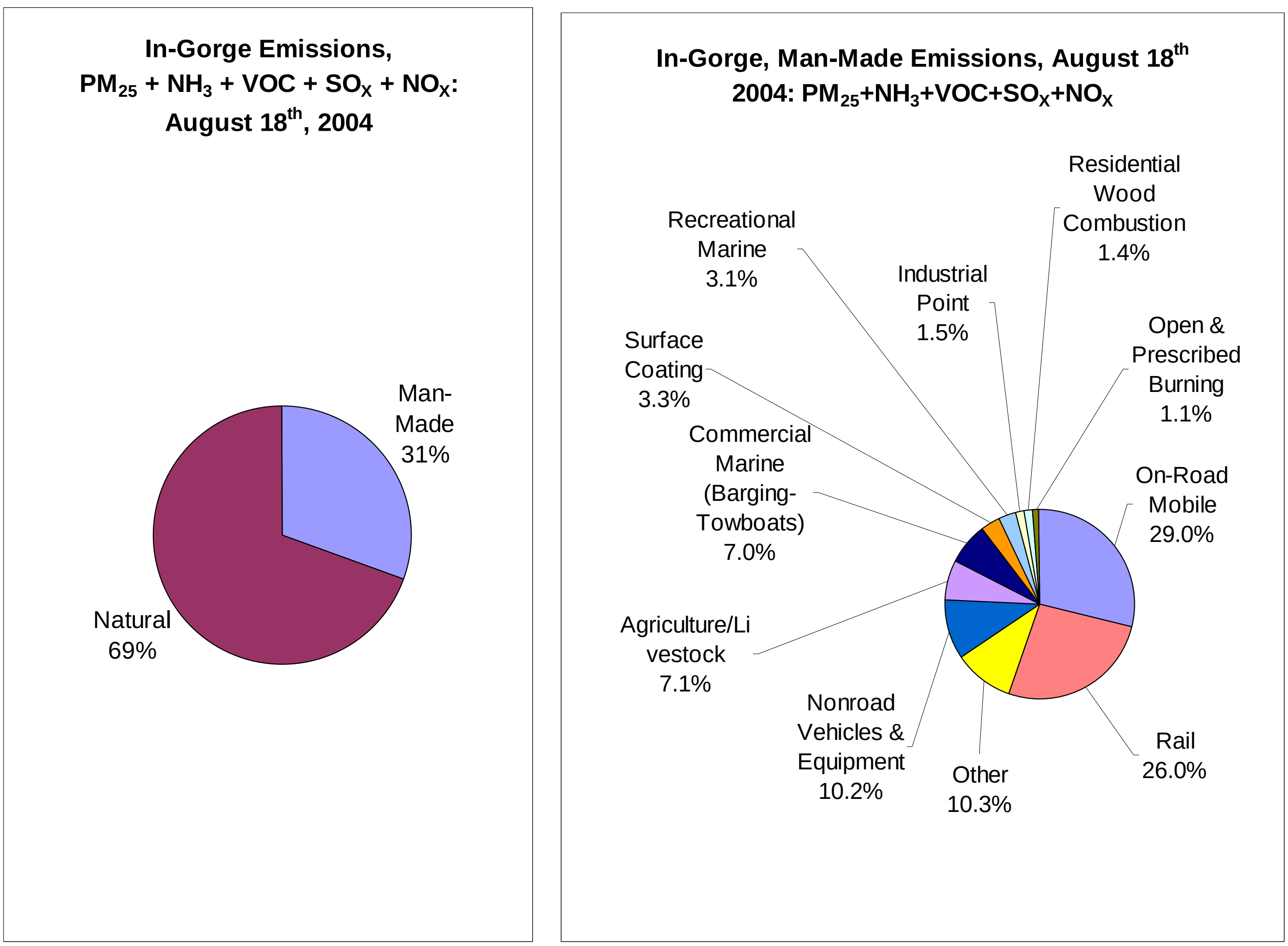
A. In-Gorge Source Contributions

The In-Gorge area (Region 1) comprises of the immediate Columbia Gorge Scenic Area including parts of Multnomah, Hood, Wasco, and Sherman counties in Oregon and Skamania, Klickitat, and Clark counties in Washington. The source categories were determined by identifying all the man-made source categories that were contributing to In-Gorge emissions. DEQ identified and grouped these categories according to similar category groupings (e.g. the agricultural source category consists of nonroad – agricultural, fertilizer operations, and orchard heaters, etc.), the amount of emissions for each category, and source categories of interest. For further information on how the man-made emission source categories were grouped, please refer to Appendix A.

In-Gorge area emissions are the smallest contributor to the Gorge modeling domain. Over half of the emissions identified in this region are comprised of natural sources. Because of its small geographic size and the absence of other significant contributors, the largest emitter of emissions comes from on-road mobile sources, at about 15 tons/day.

Figure 6 shows source contributions for August 18, 2004, Region 1: In Gorge. Natural sources comprise 69% of the overall emissions In-Gorge, with 31% coming from man-made sources. A distribution of source categories that comprise the man-made contribution to In-Gorge emissions is shown in the accompanying pie chart. On-road mobile and rail emissions account for over 50% of the man-made source contribution. The "Other" source category includes emissions from degreasers, miscellaneous commercial, household, and industrial area sources, and fuel storage, etc.

Figure 6: In-Gorge Emissions, August 18, 2004



When the Gorge Technical Team reviewed the emissions contribution from In-Gorge sources, it identified an increase in emissions from industrial point sources from 2004 to 2018. A secondary aluminum plant was the sole source of the increased emissions. After examination of local conditions and receiving information from the secondary aluminum plant on their expected growth, the emissions projections for the aluminum plant was revised to accurately represent expected growth.

In **Figure 7**, the "modeled" emissions pie charts, natural emissions are 56% and man-made emissions are 44% of the total source contribution to In-Gorge emissions. The accompanying pie chart shows the man-made emissions distributed by source category. Industrial point sources account for 50%, with on-road mobile, rail, and nonroad vehicle and equipment totaling about 25%. The category groupings are the same as what was used for August 2004.

The industrial point sources incorrectly account for over half of the emissions in 2018 in the "modeled" pie chart. The "adjusted" emissions pie charts show revised percentages based on adjusted realistic emissions projections for industry. As a result, the natural source contribution increases from 56% to 73%. In comparing the modeled and adjusted man-made emissions for point sources, the contribution decreases by a factor of 20, indicating that rail, on-road mobile, and other sources are responsible for the bulk of emissions in 2018.

Figure 7: In-Gorge Emissions, August 18, 2018 (Modeled and Adjusted)

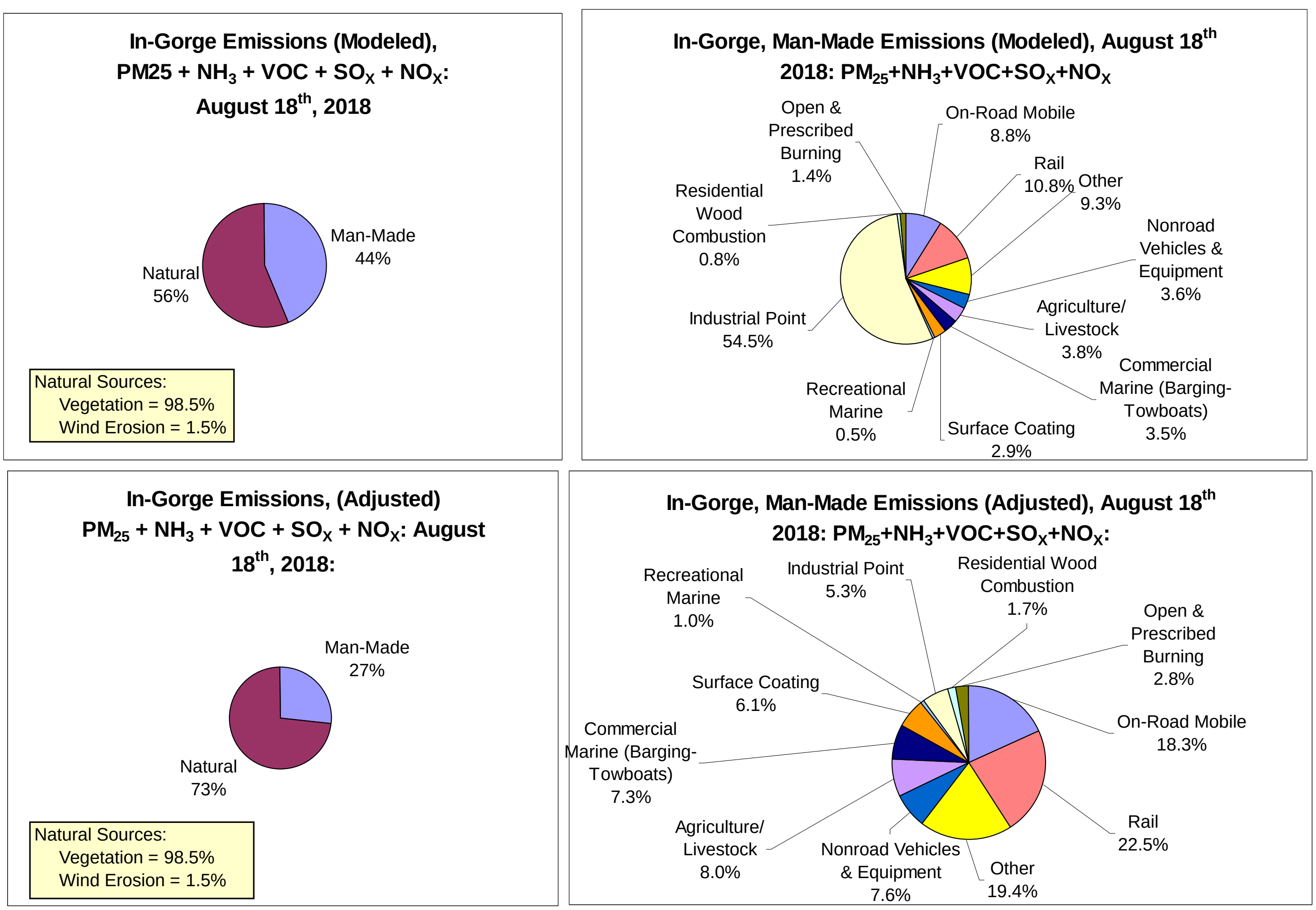


Figure 8 shows an August 18, 2004 to August 18, 2018 comparison of "In-Gorge" man-made source categories. The on-road mobile emissions decrease by 50% (14 tons/day to 7 tons/day) primarily due to EPA rules for reductions in both tailpipe emissions and fuel sulfur content. The rules were designed to reduce PM, NOx, and SOx through the use of emission control technologies in conjunction with decreased fuel sulfur content. The rules went into effect beginning in 2004 with gradual phase in. The reduction of emissions due to these rules more than offsets the expected increase in vehicle miles traveled. In addition, EPA promulgated rules regarding reduction in nonroad diesel fuel sulfur content for nonroad equipment, locomotives, and marine vessels, beginning in 2007. Rail emissions show decrease by 25% (12 tons/day to 9 tons/day) due to these regulations.

Industrial point sources show an unrealistic increase in emissions from 1 ton/day to 45 tons/day based on incorrect growth assumptions from EPA's Economic Growth and Analysis System growth factor model (EGAS). WRAP utilized this model when making the 2018 EI projections for industry. The Gorge Technical Team utilized these point source emissions for the model, but upon further examination determined the future projections were incorrect because the realistic growth of secondary aluminum production is expected to be minimal. The "other" source category also shows growth from 2004 to 2018, due to expected population growth and increased use in degreasing and miscellaneous solvent use.

Figure 8: In-Gorge Man-Made Emissions (Modeled), August 18th

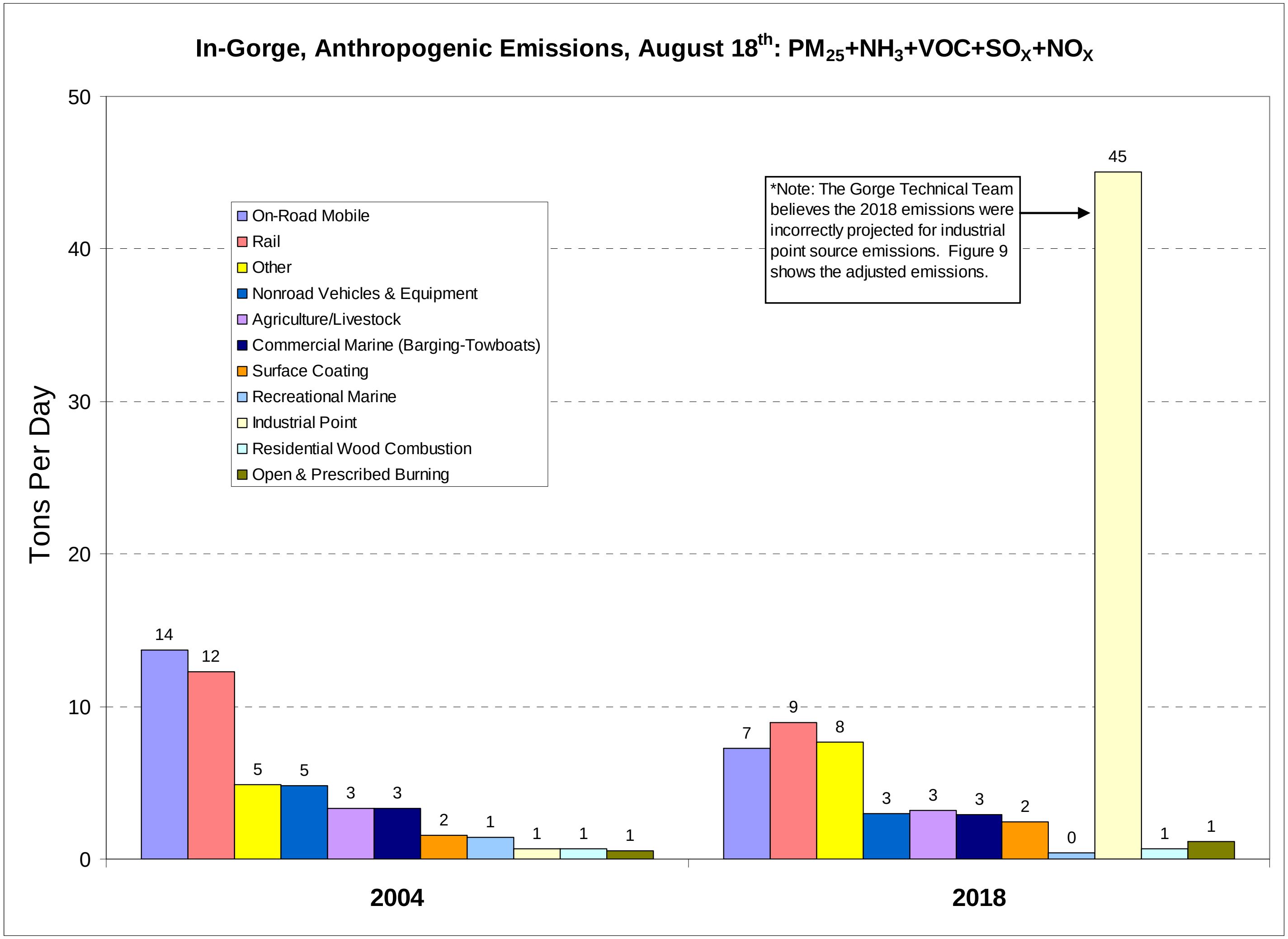


Figure 9 shows the adjusted emissions to the industrial point sources. The Gorge Technical Team noted there was one identified source showing a 44 ton increase in emissions from 2004 to 2018. After receiving information from the source (a secondary aluminum production plant) the emissions were adjusted to show a projected increase of three times the 2004 emissions. The adjusted 2018 industrial point emissions account for 2 tons/day, and reflect a 100% increase from 2004 emissions.

Figure 9: In-Gorge, Man-made Emissions, August 18th (Adjusted)

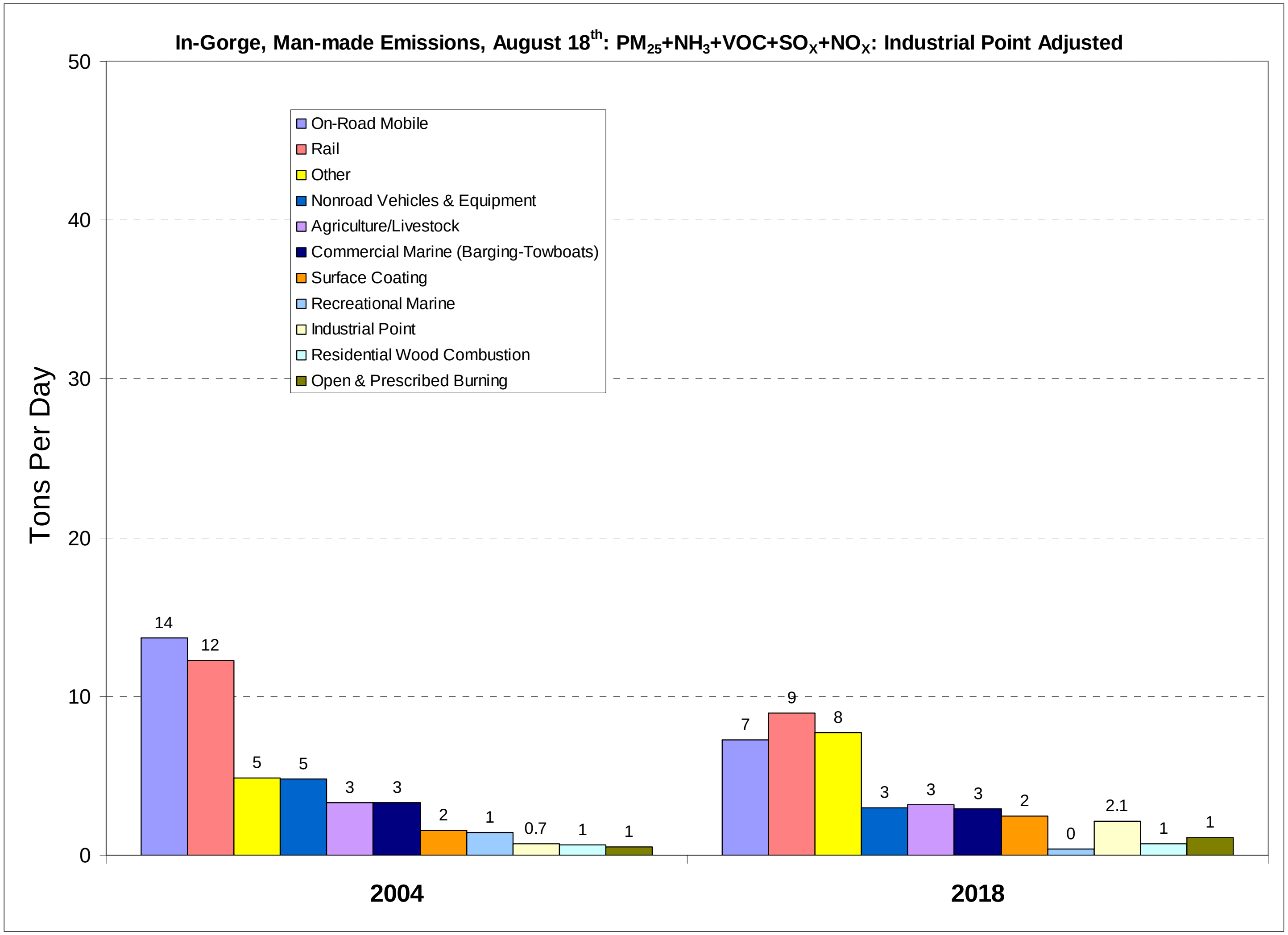
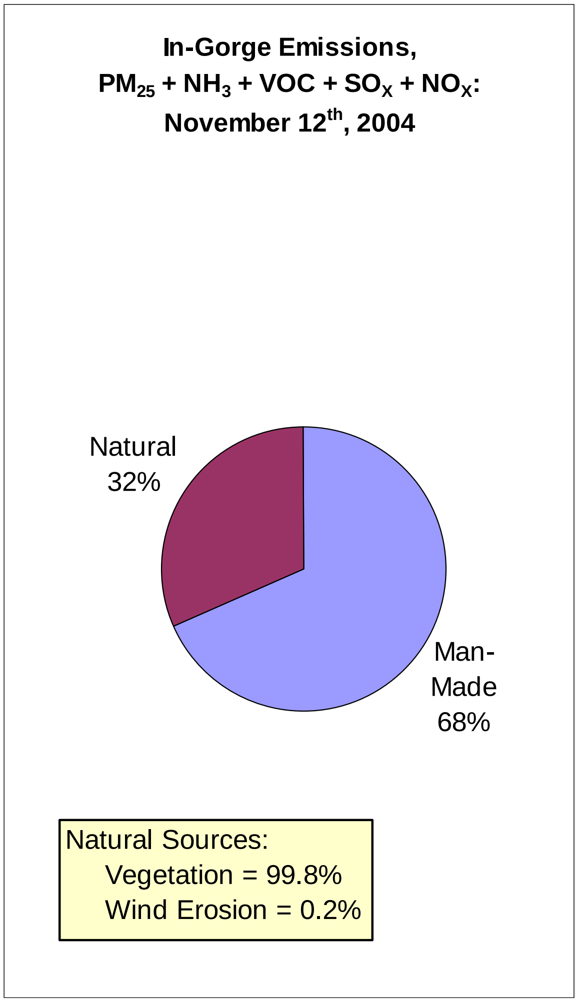


Figure 10 shows source contributions for November 12, 2004, Region 1 – In Gorge. Man-made sources account for 68% of the overall emissions for In-Gorge region, with natural sources comprising 32%. The accompanying pie chart shows the distribution of source categories that contribute to man-made sources. Prescribed burning and on-road mobile each contribute almost 25% each while rail emissions contribute 18% to man-made sources. The "Other" source category includes emissions from commercial and industrial solvent use, degreasers, fuel storage, and stationary source fuel combustion, etc.

Figure 10: In-Gorge Emissions, November 12, 2004



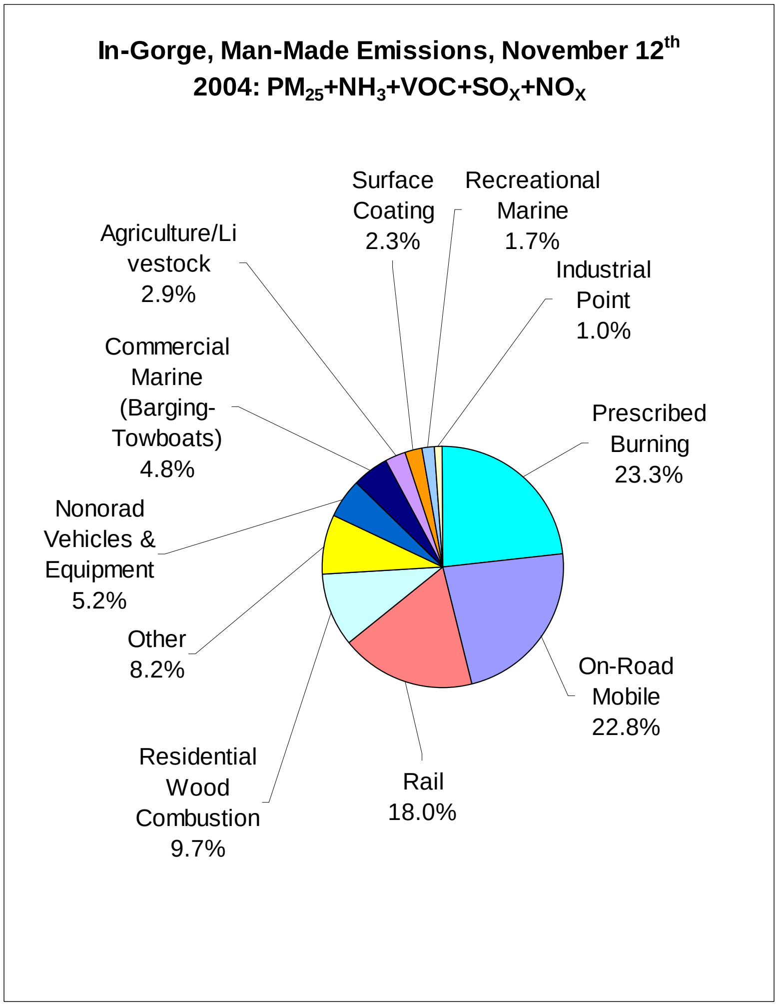
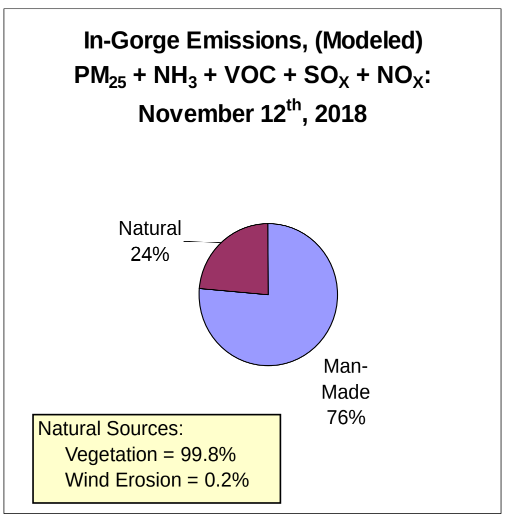


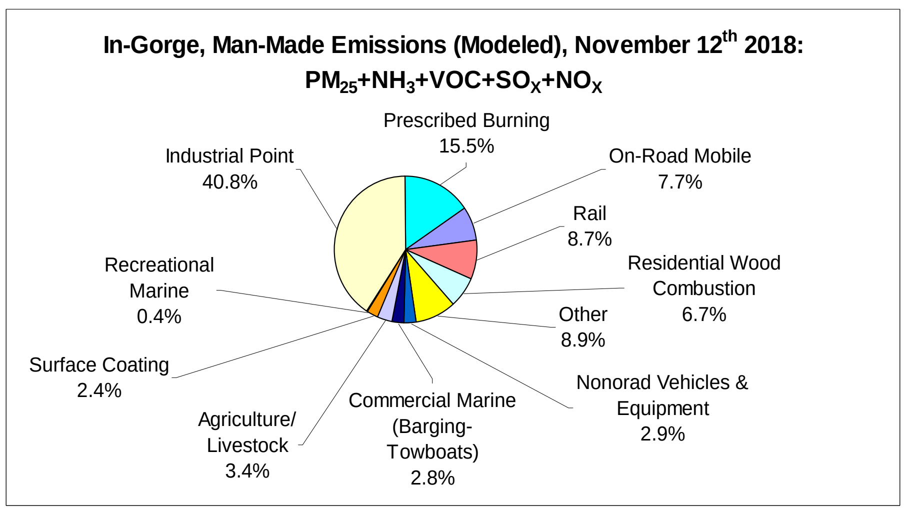
Figure 11 shows source contributions for November 12, 2018, Region 1 – In Gorge. As with the August episode, the secondary aluminum plant was the sole source of the increased emissions and after an examination of local conditions, the emissions projections for the aluminum plant was revised to more accurately represent expected growth. The 2018 "adjusted" emissions were projected to be three times the 2004 levels, after receiving information from the secondary aluminum plant on their expected growth.

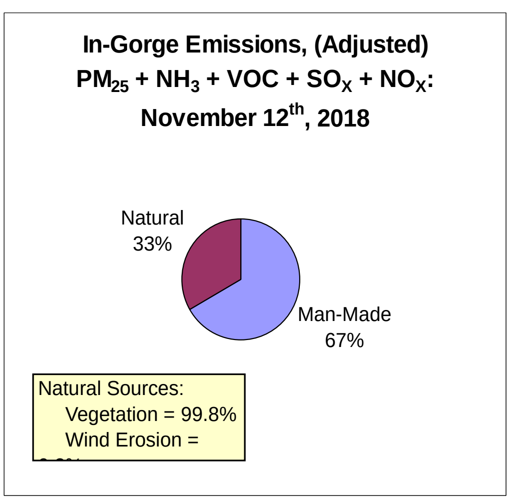
In the "modeled" emissions pie charts, man-made emissions are 76% and natural emissions are 24% of the total source contribution to In-Gorge emissions. The accompanying pie chart shows the man-made emissions distributed by source category. Industrial point sources account for 40% with prescribed burning contributing 15%. The category groupings are the same for November 2004.

The industrial point sources account for almost half of the emissions modeled in 2018, the "adjusted" emissions pie charts show revised percentages based on adjusted emissions projections for industry. In comparing the modeled and adjusted man-made emissions for point sources, the contribution decreases by a factor of 10, indicating that prescribed burning rail, on-road mobile, and other sources are responsible for bulk of man-made emissions in 2018.

Figure 11: In-Gorge Man-made Emissions, November 12th (Modeled and Adjusted)







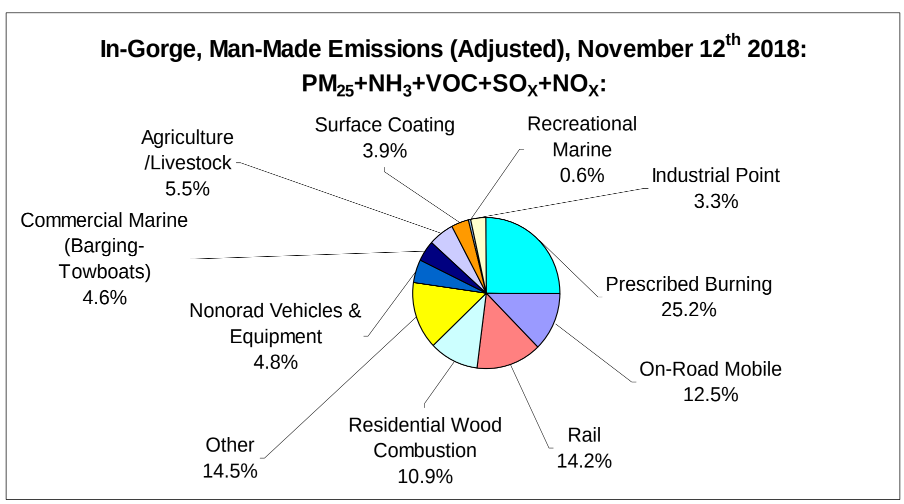


Figure 12 shows a comparison of man-made sources for November 12, 2004 and 2018. Prescribed burning emissions stay the same from 2004 to 2018. On-road mobile emissions decrease by 50% (16 tons/day to 8 tons/day) and rail emissions decrease by 25% (12 tons/day to 9 tons/day) due to EPA's ultra low sulfur fuel rules. The ultra low sulfur fuel rules went into effect in 2007, resulting in a decreased amount of sulfur that is allowed in fuel, for nonroad equipment, locomotives, and marine vessels. Industrial point sources show an unrealistic increase in emissions from1 ton/day to 42 tons/day. These growth assumptions were based on EPA's Economic Growth and Analysis System growth factor model (EGAS). WRAP utilized this model when making the 2018 EI projections for industry. As with the August episode, the Gorge Technical Team utilized these point source emissions for the model, but upon further examination determined the future projections were incorrect. The emissions increase primarily came from one source – secondary aluminum production and the expected growth in this category is minimal. Agricultural emissions show an increase of 50% (from 2 tons/day to 3 tons/day), due to a projected increase in livestock operations. The "other" source category also shows growth from 2004 to 2018, primarily due to expected increases in miscellaneous commercial and industrial area sources and open burning.

Figure 12: In-Gorge, Man-made Emissions, November 12th (Modeled)

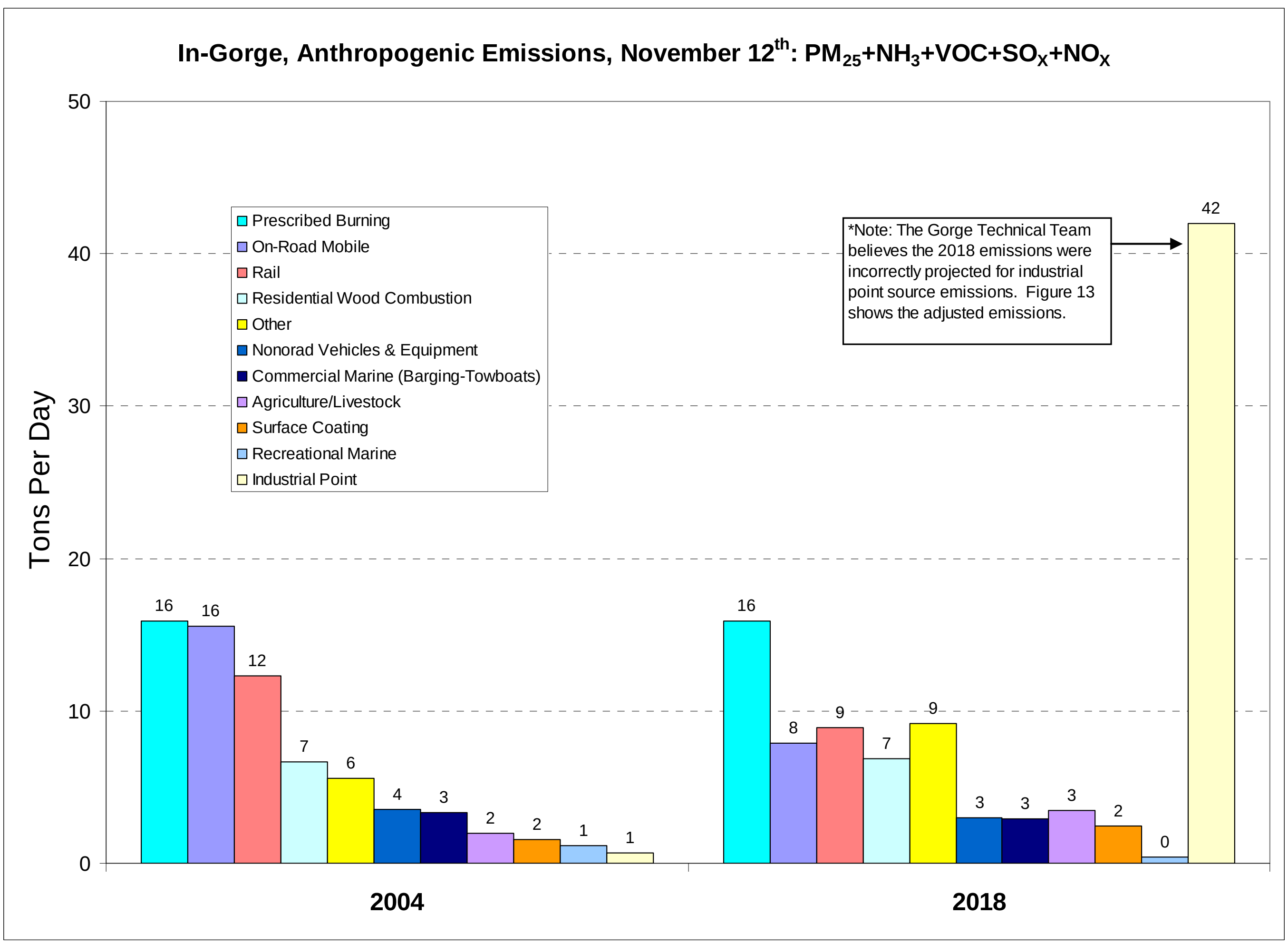
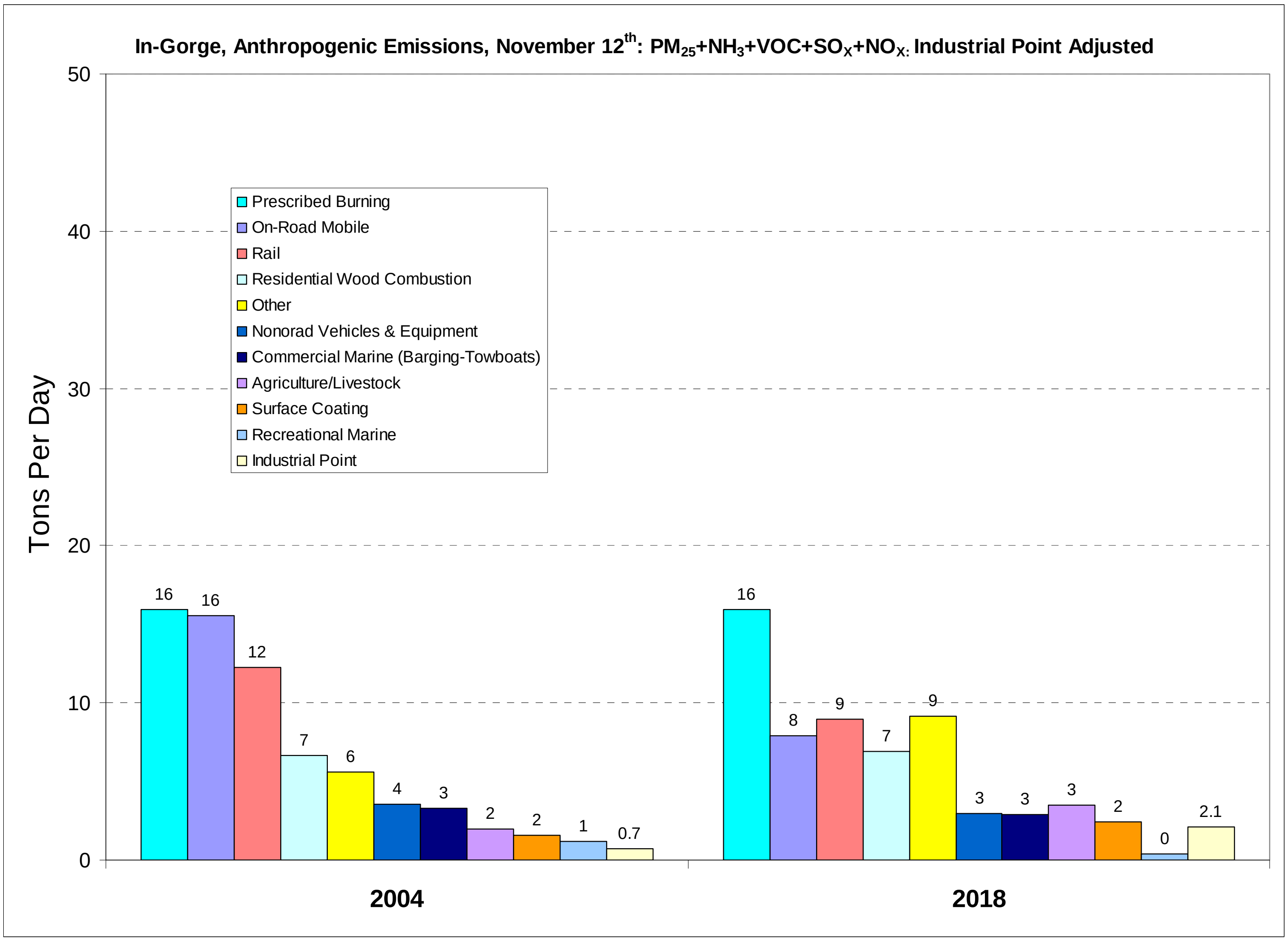


Figure 13 shows the adjusted emissions for November 2018. Industrial point emissions show a modest increase from 1 ton/day to 2 tons/day. The Gorge Technical Team noted there was one identified source showing a 41 ton increase in emissions from 2004-2018. After receiving information from the source (a secondary aluminum production plant) the emissions were adjusted to show a projected increase of three times the 2004 emissions. The adjusted 2018 industrial point emissions account for 2 tons/day, and reflect a 100% increase from 1 ton/day 2004 emissions.

Figure 13: In-Gorge, Man-made Emissions, November 12th (Adjusted)

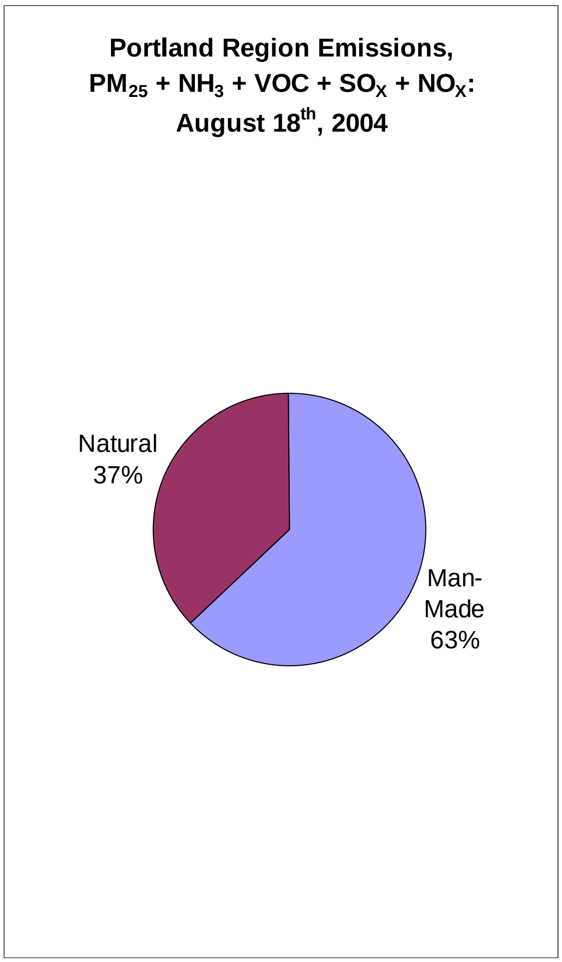


B. Portland Source contributions

The Portland area (Region 2) comprises the metropolitan Portland, Oregon / Vancouver, Washington area. As with the In-Gorge source category emissions, the source categories were determined by identifying all the man-made source categories that contribute to Portland area emissions. DEQ identified and grouped these categories according to similar category groupings (e.g. the agricultural source category consists of nonroad – agricultural, fertilizer operations, and orchard heaters, etc.), the amount of emissions for each category, and source categories of interest. For further information on how the man-made emission source categories were grouped, please refer to Appendix A.

Figure 14 shows source contributions for August 18, 2004, Region 2: Portland. Man-made sources account for 63% of the overall emissions for In-Gorge region, with natural sources comprising 37%. The accompanying pie chart, shows the distribution of source categories that contribute to man-made sources. On-road mobile contributes 34% and nonroad vehicles contribute 14% to man-made sources. "Miscellaneous Area Sources" category is a combination of solvent applications, including graphic arts, and commercial and industrial uses. The "Other" source category includes emissions from residential wood combustion, fuel storage, open burning, and fugitive dust, etc.

Figure 14: Portland Emissions, August 18, 2004



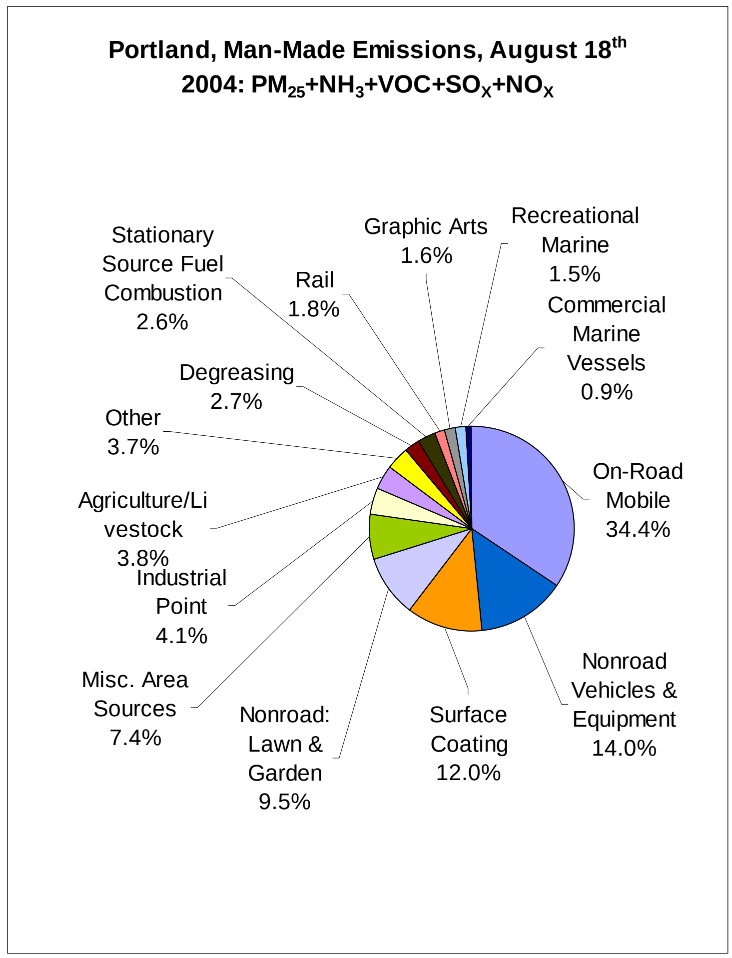
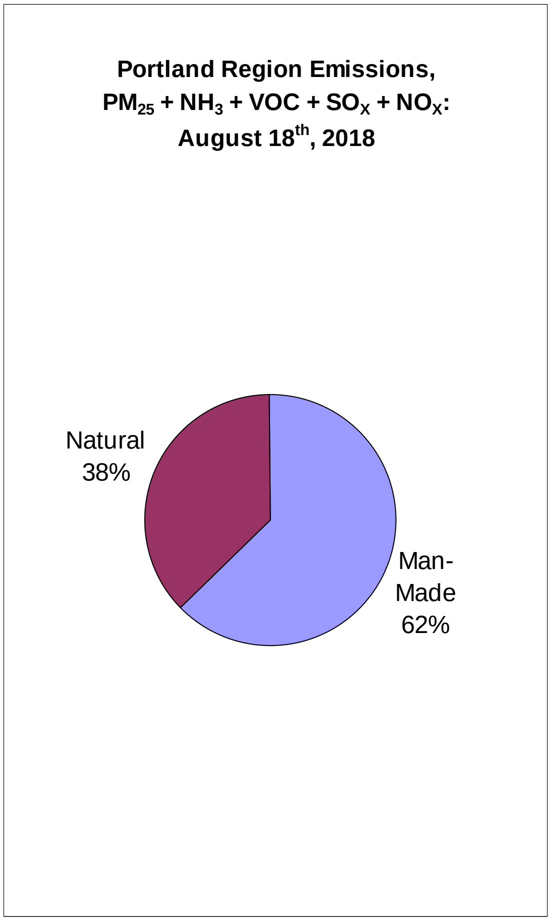


Figure 15 shows source contributions for August 18, 2018, Region 2: Portland. Natural emissions are 62% and man-made emissions are 38% of the total source contribution to Portland emissions. The accompanying pie chart shows the man-made emissions distributed by source category. Surface coating emissions account for 21%, on-road mobile emission account for 15%, and degreasing comprises 11% of the man-made emissions. The category groupings are the same as for August 2004.

Figure 15: Portland Emissions, August 18, 2018



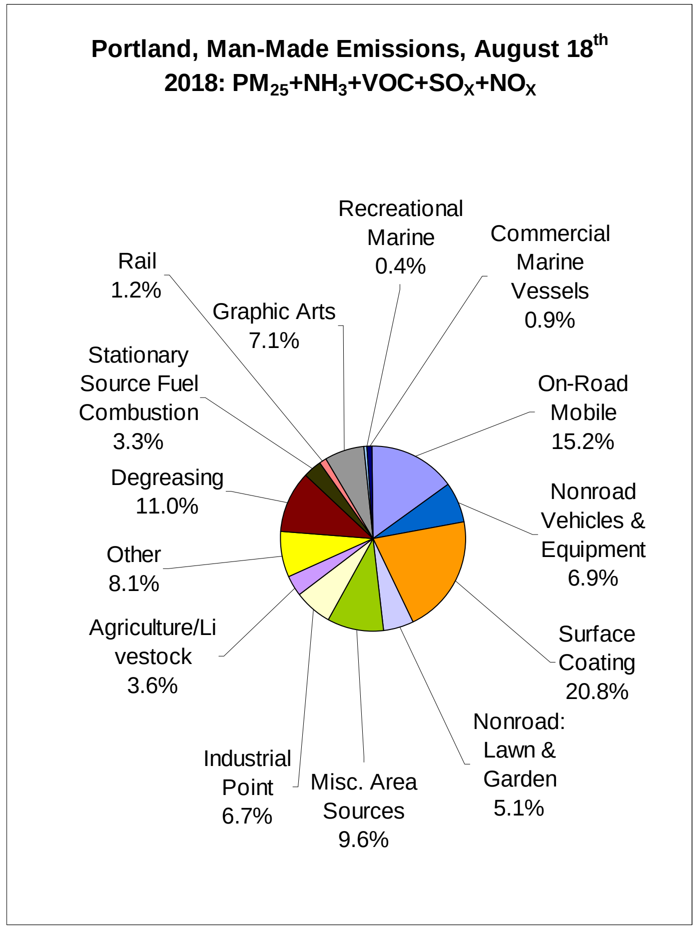


Figure 16 shows a comparison of man-made sources for August 18, 2004 and 2018. On-road mobile emissions decrease by about 57% (172 tons/day to 75 tons/day), nonroad vehicles and equipment emissions decrease by about 50% (70 tons/day to 34 tons/day), and nonroad: lawn and garden emissions also decrease by 50% (48 tons/day to 25 tons/day) due to EPA's ultra low sulfur fuel rules. The ultra low sulfur fuel rules went into effect in 2007, resulting in a decreased amount of sulfur that is allowed in fuel, for nonroad equipment (including lawnmowers), locomotives, and marine vessels. Surface coating sources show a 70% increase (60 tons/day to 103 tons/day), miscellaneous area sources increase by 29% (37 tons/day to 48 tons/day), degreasing emissions increase by 315% (13 tons/day to 54 tons/day), graphic arts increase by 337% (8 tons/day to 35 tons/day), and industrial point sources show a 57% increase in emissions (21 ton/day to 33 tons/day) all due to growth assumptions based on WRAP's utilization of EPA's Economic Growth and Analysis System growth factor model (EGAS). The "other" source category also shows growth from 2004 to 2018, primarily due to expected increases in dry cleaning use, emissions increases in commercial food preparation, and open burning.

Figure 16: Portland, Man-made Emissions, August 18th

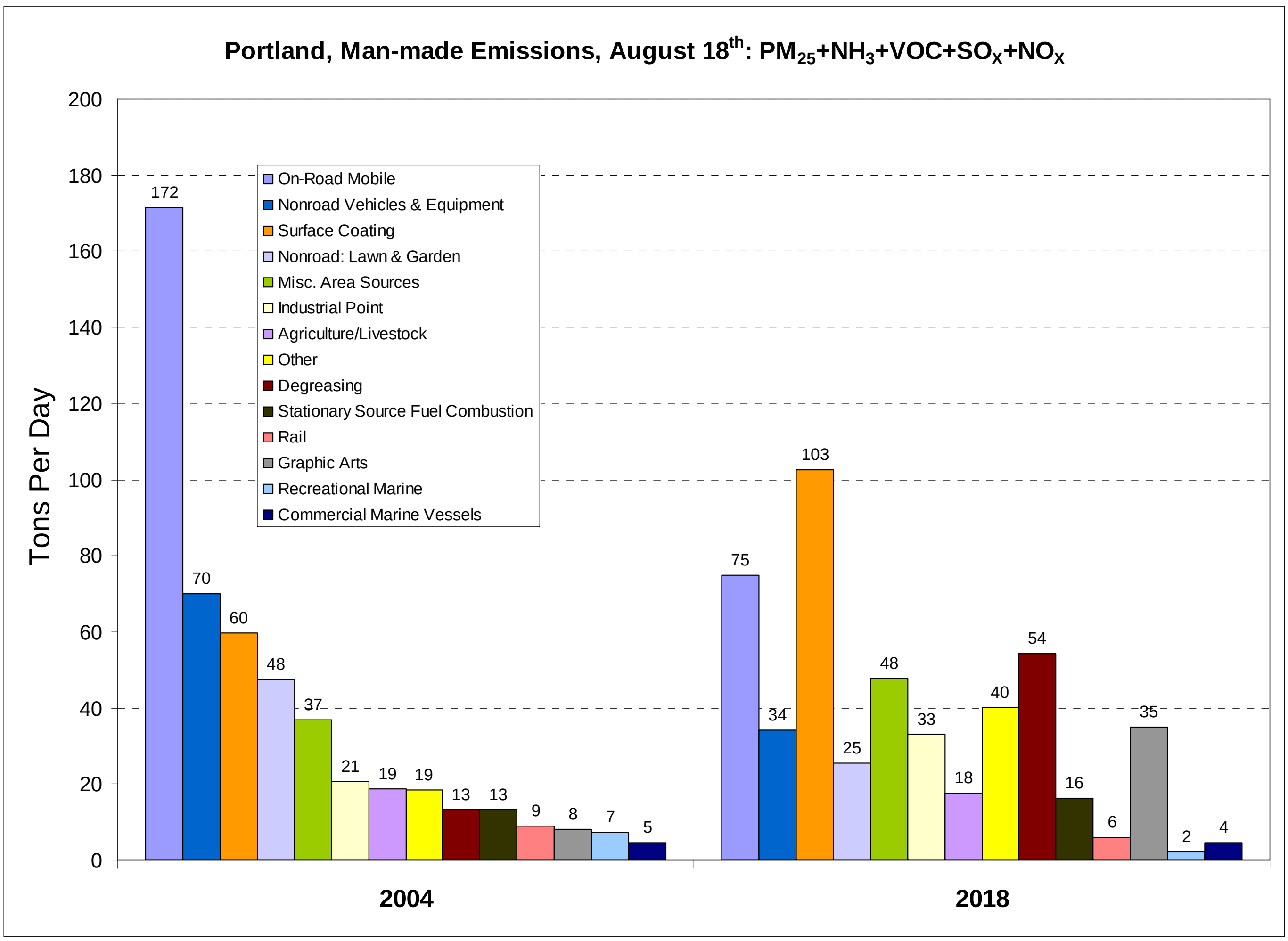
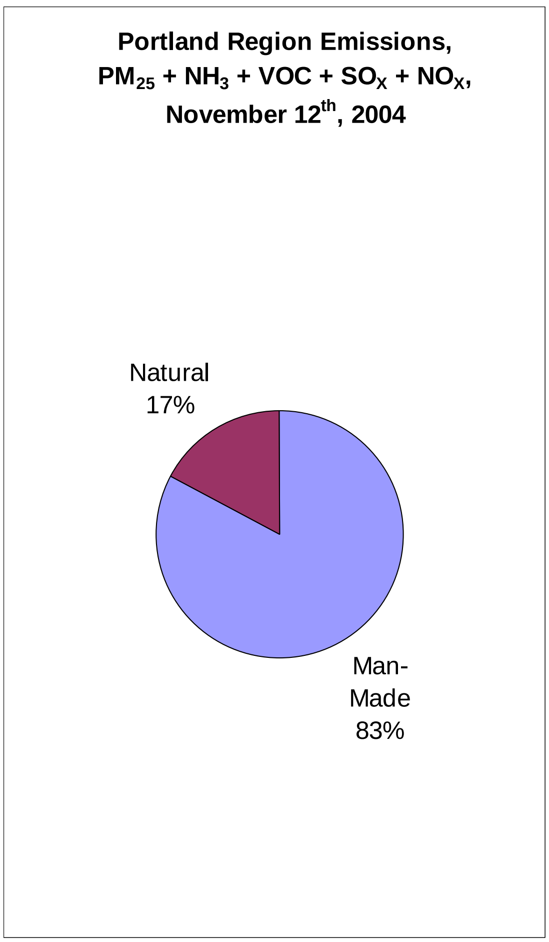


Figure 17 shows source contributions for November 12, 2004, Region 2 – Portland. Man-made sources account for 83% of the overall emissions for Portland area region, with natural sources comprising 17%. The accompanying pie chart shows the distribution of source categories that contribute to man-made sources. On-road mobile contributes 36%, residential wood combustion and surface coating together contribute 25% of emissions from man-made sources. "Miscellaneous Area Sources" include commercial and industrial solvent use and degreasing. The "Other" source category includes emissions from open and prescribed burning, fuel storage, and fugitive dust, etc.

Figure 17: Portland Emissions, November 12, 2004



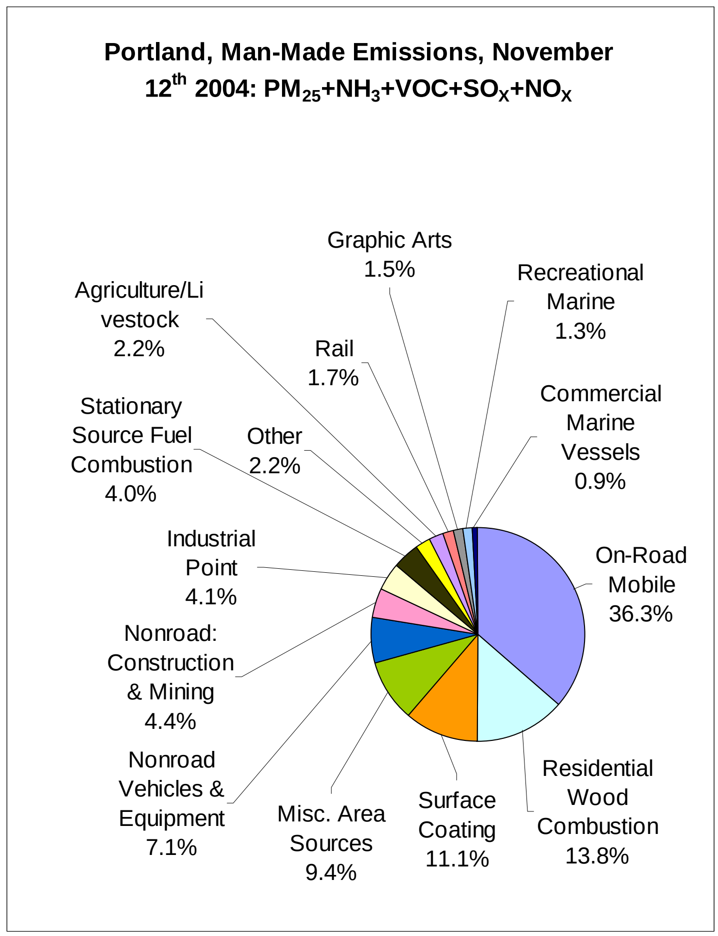
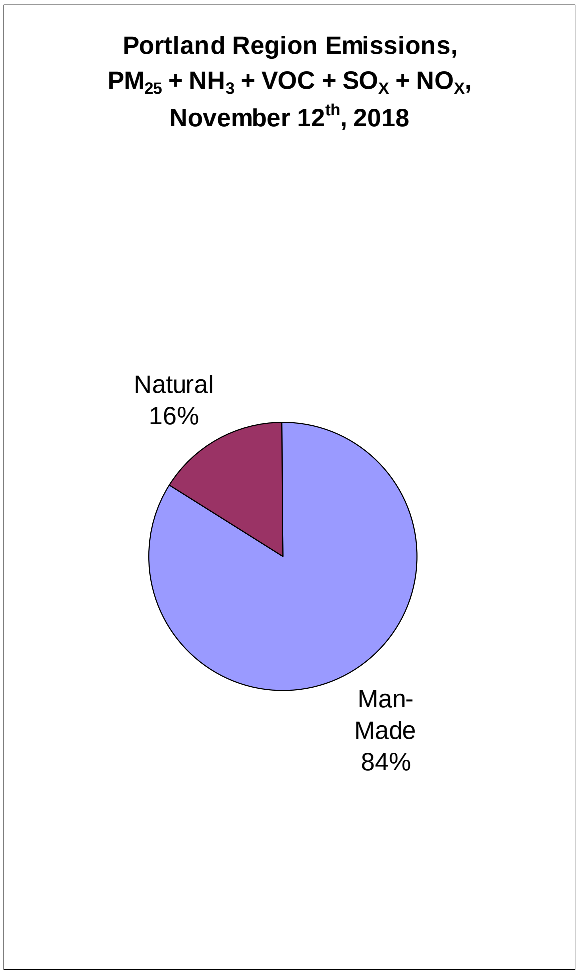


Figure 18 shows source contributions for November 12, 2018, Region 2 - Portland. Man-made emissions are 84% and natural emissions are 16% of the total source contribution to Portland area emissions. The accompanying pie chart shows the man-made emissions distributed by source category. Surface coating and miscellaneous area sources each contribute 18%, with on-road mobile (14%) and residential wood combustion (13%) contributing to the man-made portion of the pie. The category groupings are the same for November 2004.

Figure 18: Portland Emissions, November 12, 2018



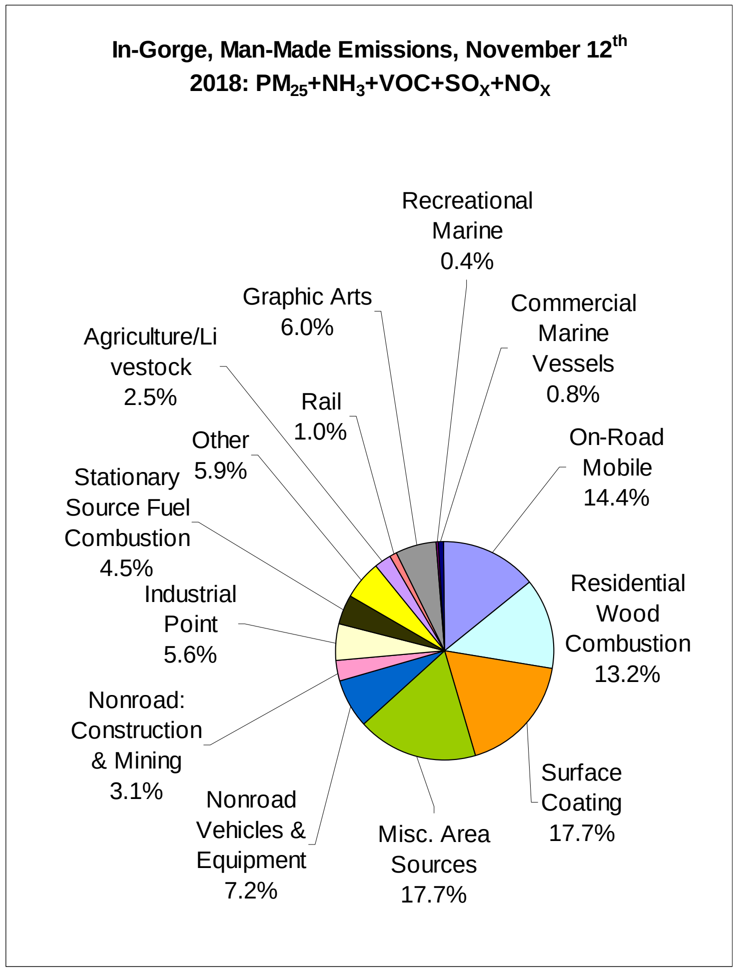
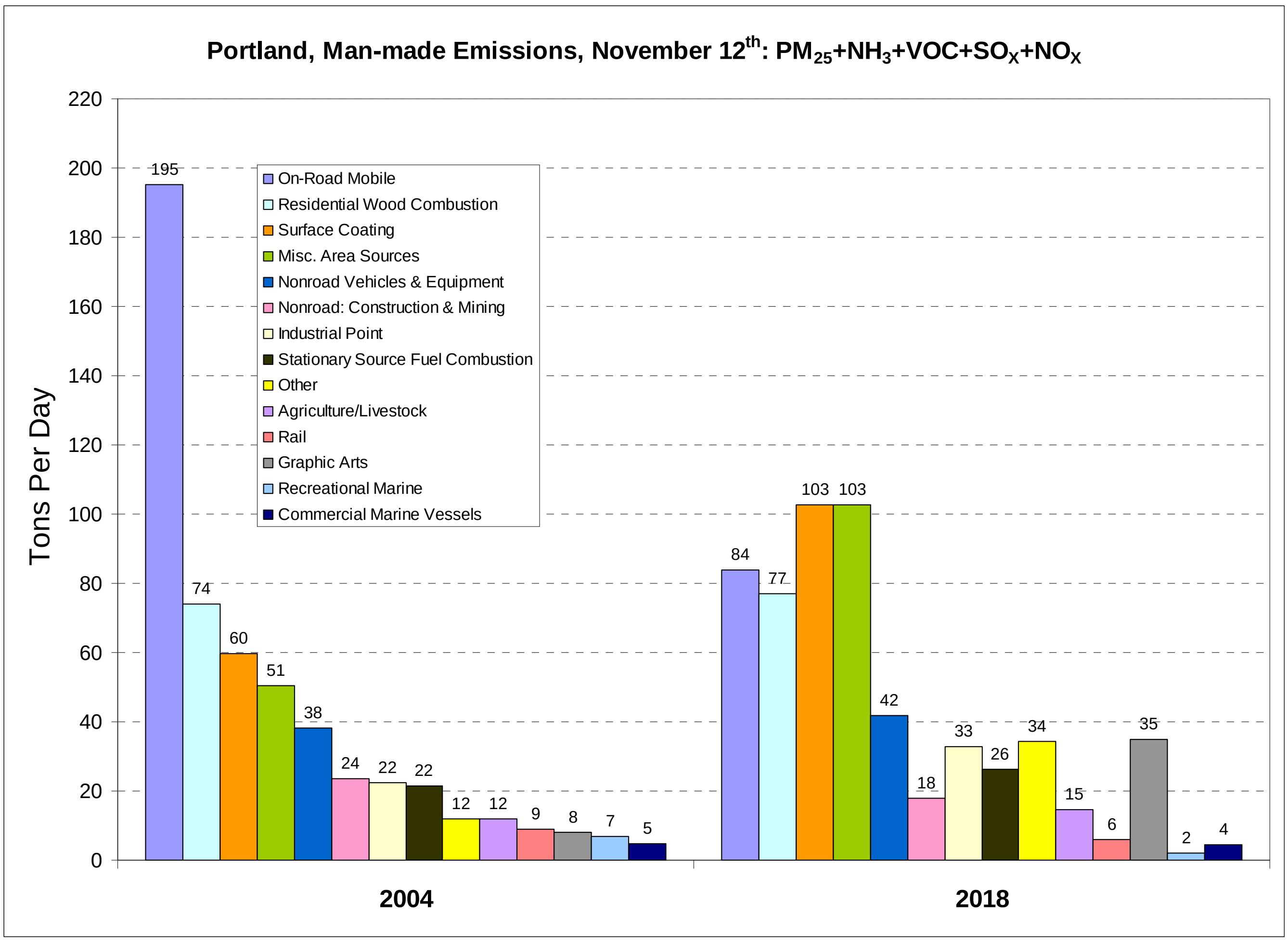


Figure 19 shows a comparison of man-made sources for November 12, 2004 and 2018. On-road mobile emissions decrease by 57% (195 tons/day to 84 tons/day) due to EPA's ultra low sulfur fuel rules. Residential wood combustion changes from 74 tons/day in 2004 to 77 tons/day in 2018. Surface coating sources show a 72% increase (60 tons/day to 103 tons/day), miscellaneous area sources increase by 101% (51 tons/day to 103 tons/day), graphic arts increase by 337% (8 tons/day to 35 tons/day), and industrial point sources show a 50% increase in emissions (22 tons/day to 33 tons/day) based on growth assumptions using EPA's Economic Growth and Analysis System growth factor model (EGAS). The "other" source category also shows growth from 2004 to 2018, due to expected increases in commercial food preparation and open burning emissions.

Figure 19: Portland, Man-made Emissions, November 12th

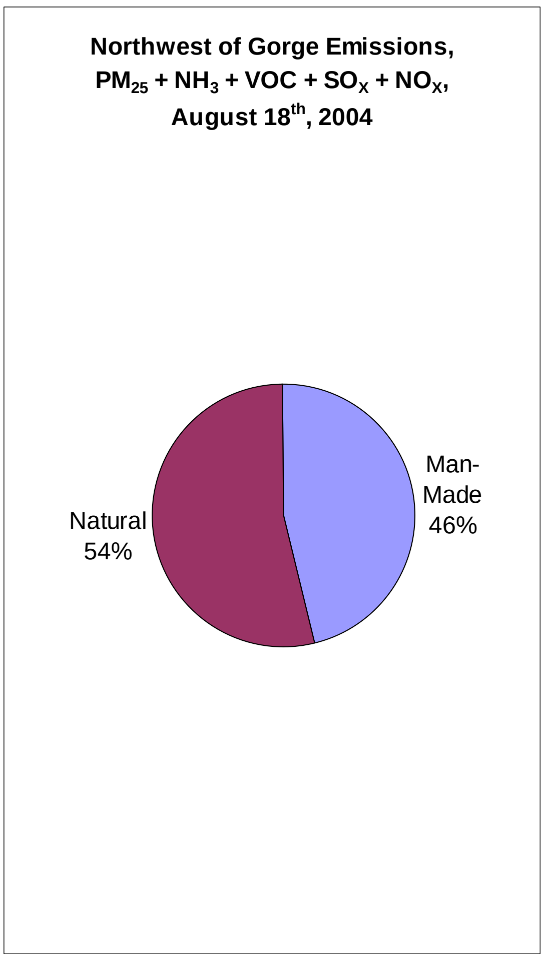


C. Northwest of Gorge Source Contribution

The Northwest of Gorge area (Region 3) comprises the area just northwest of metropolitan Portland. This consists of Clatsop and Columbia counties in Oregon and Pacific, Wahkiakum, and Cowlitz counties in Washington. As with the In-Gorge source category emissions, the source categories were determined by identifying all the man-made source categories that contribute to the Northwest of Gorge area emissions. DEQ identified and grouped these categories according to similar category groupings (e.g. the agricultural source category consists of nonroad – agricultural, fertilizer operations, and orchard heaters, etc.), the amount of emissions for each category, and source categories of interest. For further information on how the man-made emission source categories were grouped, please refer to Appendix A.

Figure 20 shows source contributions for August 18, 2004, Region 3: Northwest of Gorge. Natural sources account for 54% of the overall emissions for the Northwest of Gorge region, with man-made sources comprising 46%. In the accompanying pie chart, it shows the distribution of source categories that contribute to man-made sources. Industrial point sources contribute 58% of the man-made source pie. On-road mobile, commercial marine vessels, and nonroad vehicles and equipment cumulatively contribute over 25% of man-made emission in the Northwest of Gorge area. The "Other" source category includes emissions from fuel storage, and stationary source fuel combustion, residential wood combustion, and commercial food preparation, etc. The "miscellaneous area source" category includes industrial and commercial area sources.

Figure 20: Northwest of Gorge Emissions, August 18, 2004



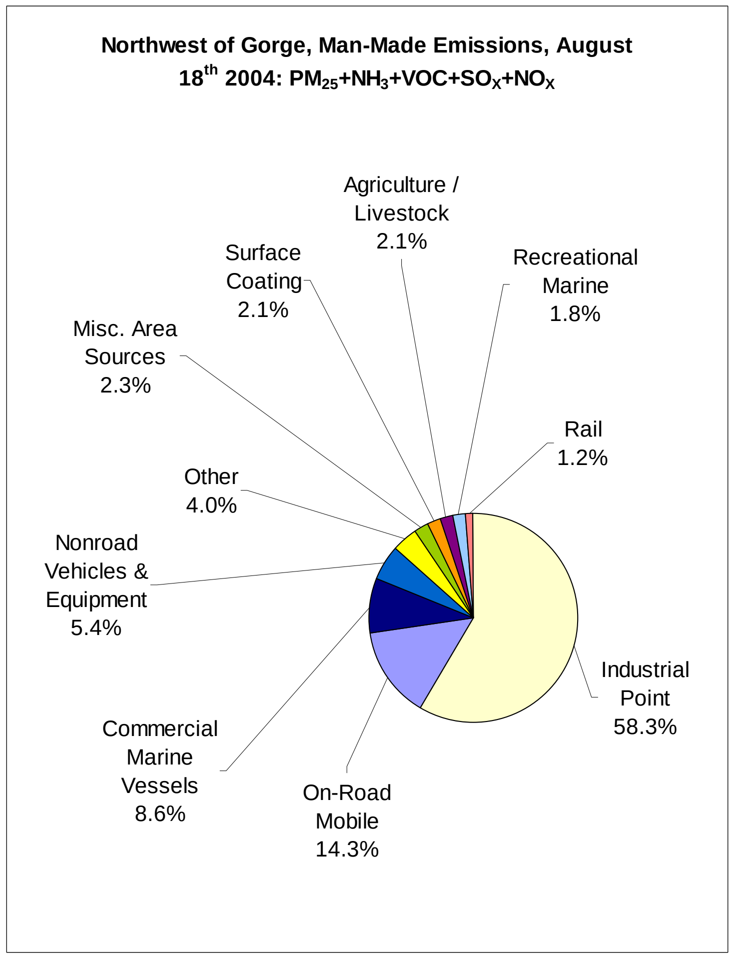


Figure 21 shows source contributions for August 18, 2018, Region 3: Northwest of Gorge. Natural emissions are 63% and man-made emissions are 37% of the total source contribution to Northwest of Gorge emissions. The accompanying pie chart shows the man-made emissions distributed by source category. Industrial point sources account for 47%, with on-road mobile, commercial marine vessels, and nonroad vehicles and equipment totaling over 25%. The category groupings are the same as for August 2004.

Figure 21: Northwest of Gorge Emissions, August 18, 2018

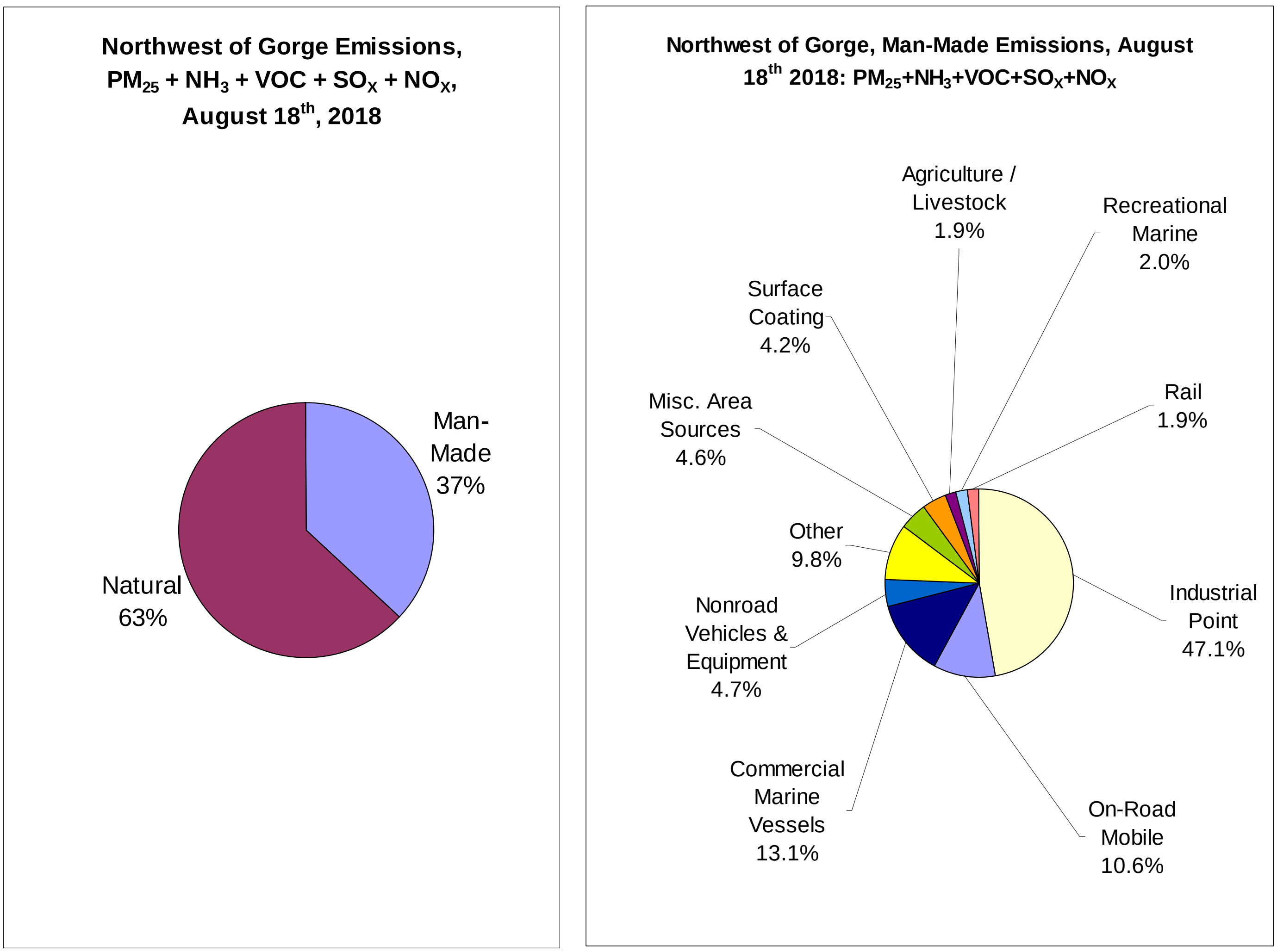


Figure 22 shows a comparison of man-made source categories from August 18, 2004 to August 18, 2018 in the Northwest of Gorge region. The chart shows industrial point emissions decrease by 45% (128 tons/day to 71 tons/day). The Gorge Technical Team discovered that one of the industrial point sources, a pulp and paper wood product source, which is located in the "West of Gorge" area had its 2004 emissions incorrectly attributed to the Northwest of Gorge area. The SOx emissions at this facility were 24 tons/day in August 2004 and 22 tons/day in November 2004. In 2018, however, its emissions were correctly attributed to its correct location in the "West of Gorge" area. As a result, the industrial point source emissions for 2004 in this region are higher than they should be. However, when the emissions are attributed to the corrected geographical region, there is still a decrease in emissions from 2004 to 2018. On-road mobile emissions decrease by 50% (31 tons/day to 16 tons/day) and nonroad vehicles & equipment decrease by 42% (12 tons/day to 7 tons/day) due to EPA's ultra low sulfur fuel rules. Commercial marine vessels remain relatively constant from 2004 to 2018.

Figure 22: Northwest of Gorge, Man-made Emissions, August 18th

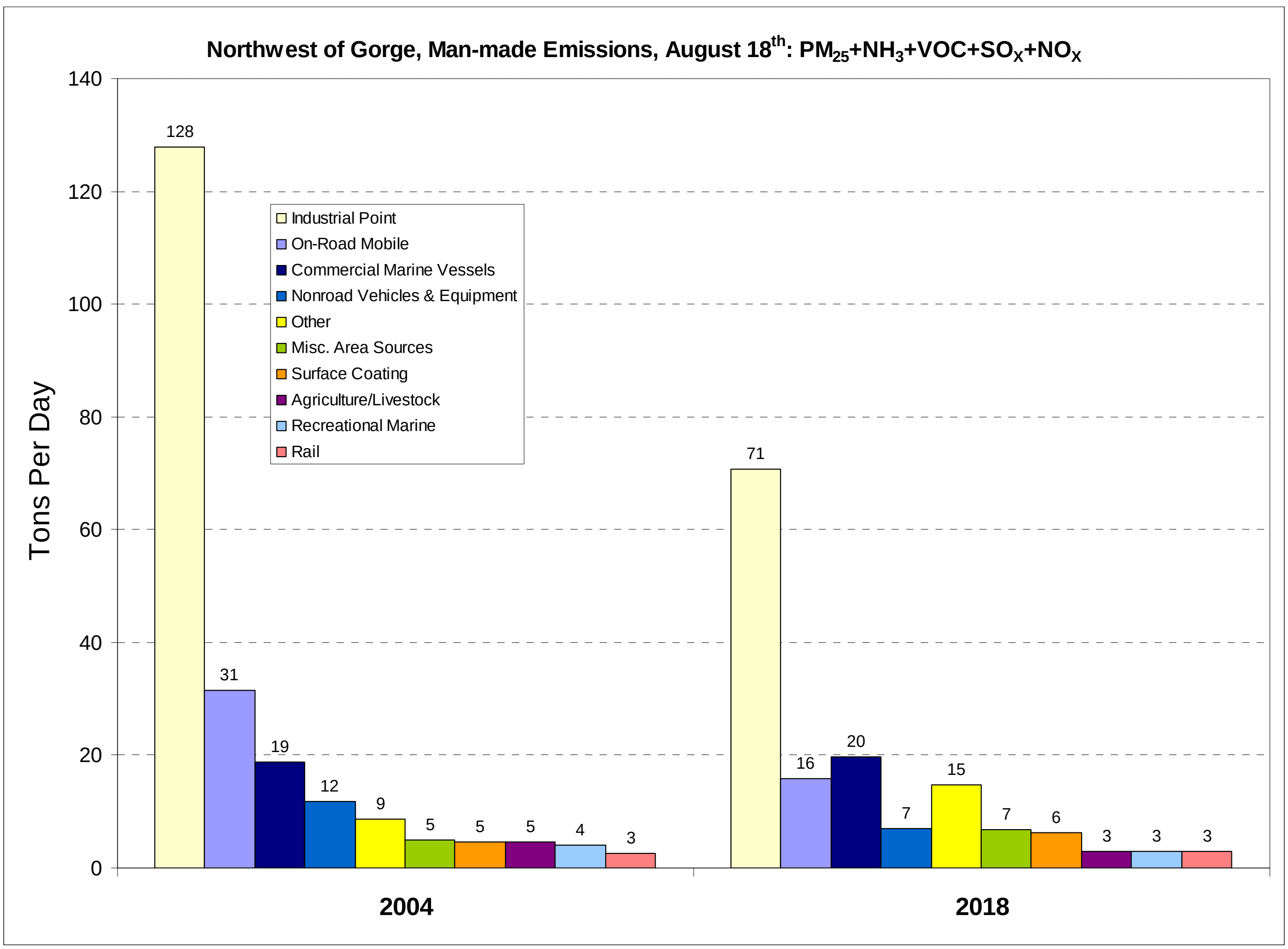
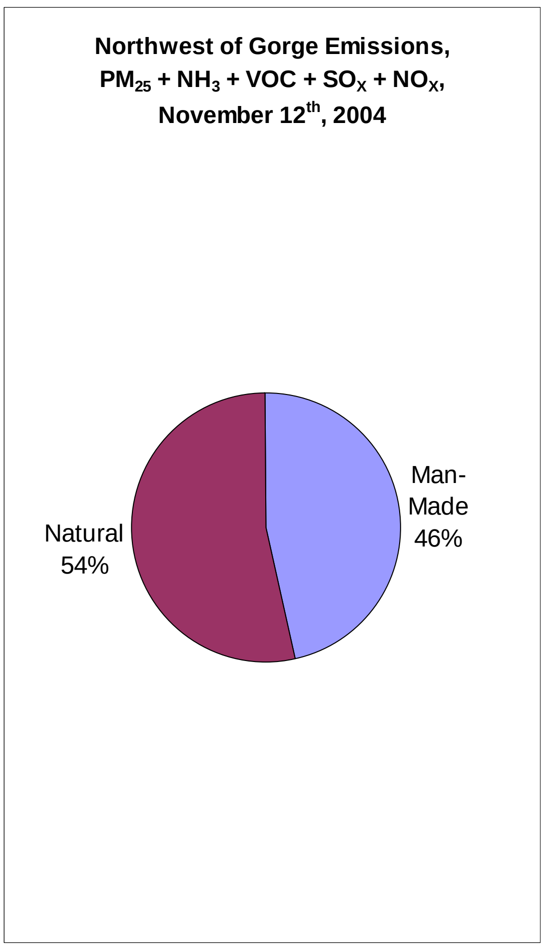


Figure 23 shows source contributions for November 12, 2004, Region 3 – Northwest of Gorge. Natural sources account for 54% of the overall emissions for the Northwest of Gorge region, with man-made sources comprising 46%. The accompanying pie chart shows the distribution of source categories that contribute to man-made sources. Industrial point sources account for 52% or the source contribution with on-road mobile and commercial marine vessels contributing 22%. Residential wood combustion contributes 8% to the man-made source pie. The "Other" source category includes emissions from stationary source fuel combustion, livestock operations, and degreasing, etc.

Figure 23: Northwest of Gorge Emissions, November 12, 2004



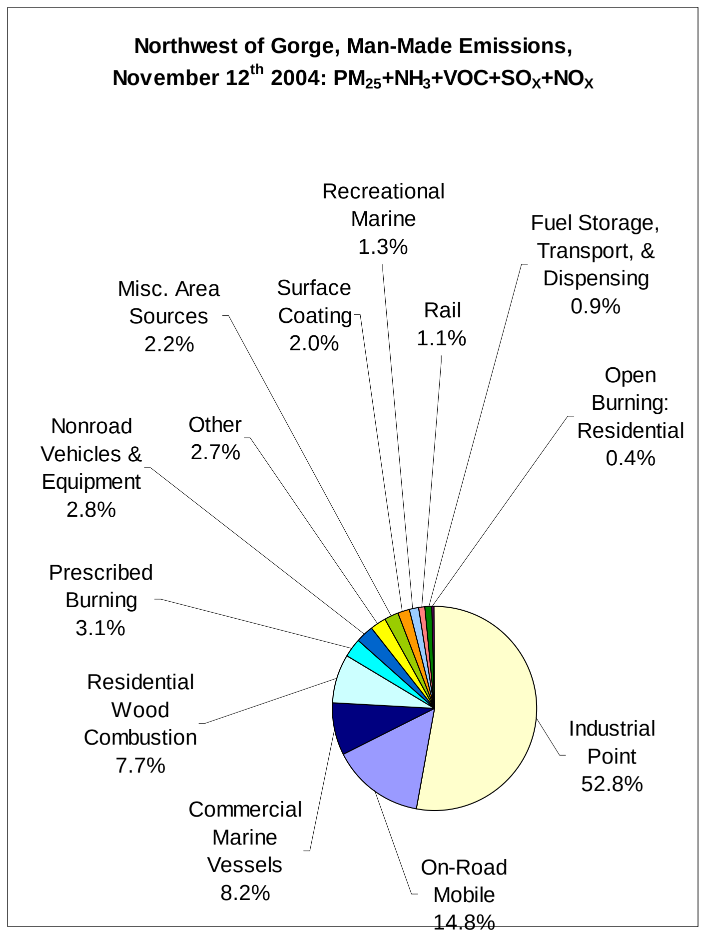


Figure 24 shows source contributions for November 12, 2018, Region 3 – Northwest of Gorge. Natural emissions are 61% and man-made emissions are 39% of the total source contribution to Northwest of Gorge emissions. The accompanying pie chart shows the man-made emissions distributed by source category. Industrial point sources account for 40%, with on-road mobile, commercial marine vessels, and nonroad vehicles and equipment totaling about 25%. Residential wood combustion and prescribed burning contribute 15% to the man-made source pie. The category groupings are the same as for November 2004.

Figure 24: Northwest of Gorge Emissions, November 12, 2018

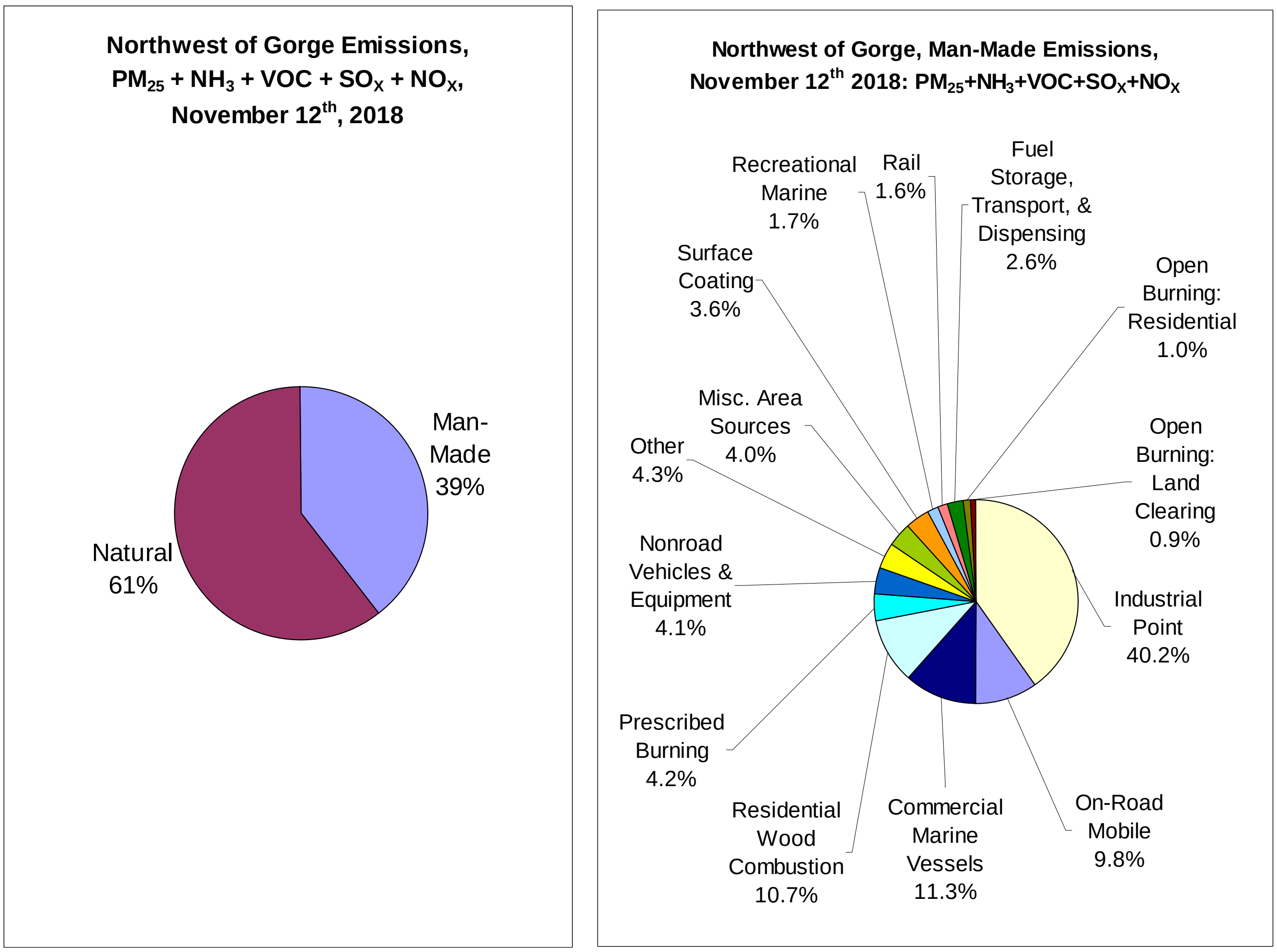
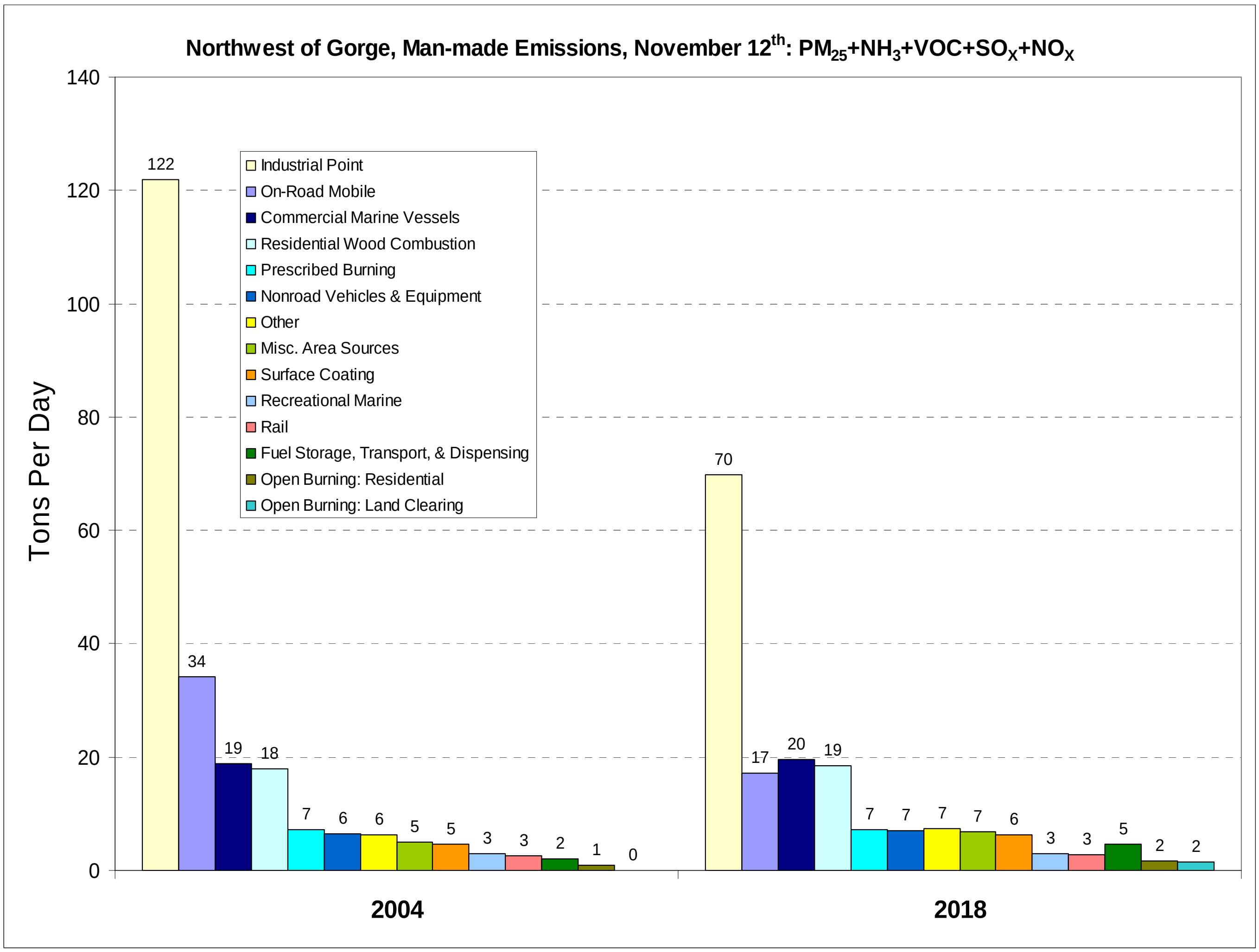


Figure 25 shows a comparison of man-made source categories in Northwest of Gorge region from November 12, 2004 to November 12, 2018. The chart illustrates industrial point emissions decreasing by 45% (122 tons/day to 70 tons/day) as a result of the misreporting of emissions for one of industrial point sources, as described in **Figure 22**. On-road mobile emissions decrease by 50% (34 tons/day to 17 tons/day) due to EPA's ultra low sulfur fuel rules. Nonroad commercial marine vessels, residential wood combustion, and the remaining source categories are relatively constant from 2004 to 2018.

Figure 25: Northwest of Gorge, Man-made Emissions, November 12th

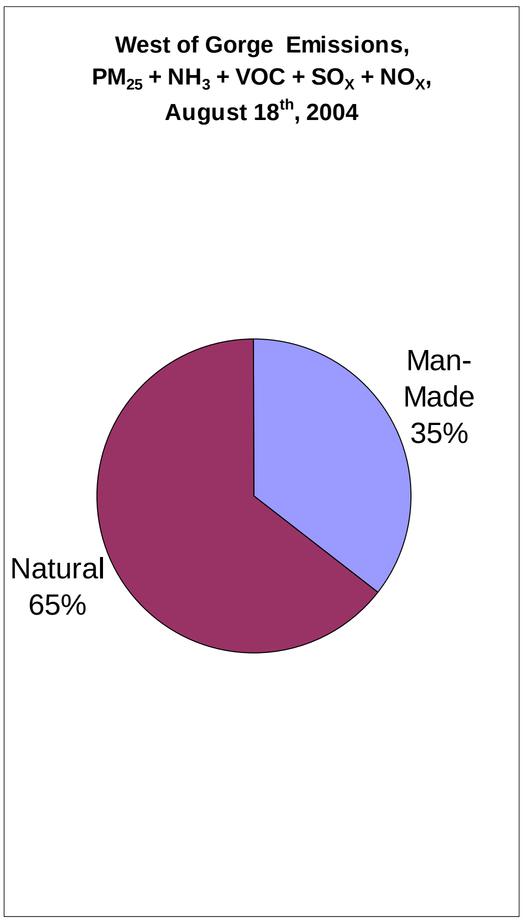


D. West of Gorge Source Contribution

The West of Gorge area (Region 4) comprises all other areas west of the Cascades. It includes the Seattle, Tacoma, and Olympia metropolitan areas and includes parts of Southern Oregon including Salem, Corvallis, and Eugene/Springfield. As with the In-Gorge emissions, the source categories were determined by identifying all the man-made source categories that contribute to West of Gorge area emissions. DEQ identified and grouped these categories according to similar category groupings (e.g. the agricultural source category consists of nonroad – agricultural, fertilizer operations, and orchard heaters, etc.), the amount of emissions for each category, and source categories of interest. For further information on how the man-made emission source categories were grouped, please refer to Appendix A.

Figure 26 shows source contributions for August 18, 2004, Region 4: West of Gorge. Natural sources account for 65% of the overall emissions for the West of Gorge region, with man-made sources comprising 35%. The accompanying pie chart shows the distribution of source categories that contribute to man-made sources. On-road mobile emissions contribute almost 45%, nonroad vehicles 11%, and industrial point sources 8% to man-made sources. The "Other" source emissions are comprised of residential wood burning, incineration, dry cleaning, and commercial food preparation, etc. "Misc. Area Sources" emissions consist of solvent use from industry and commercial activity, including degreasing and graphic arts.

Figure 26: West of Gorge Emissions, August 18, 2004



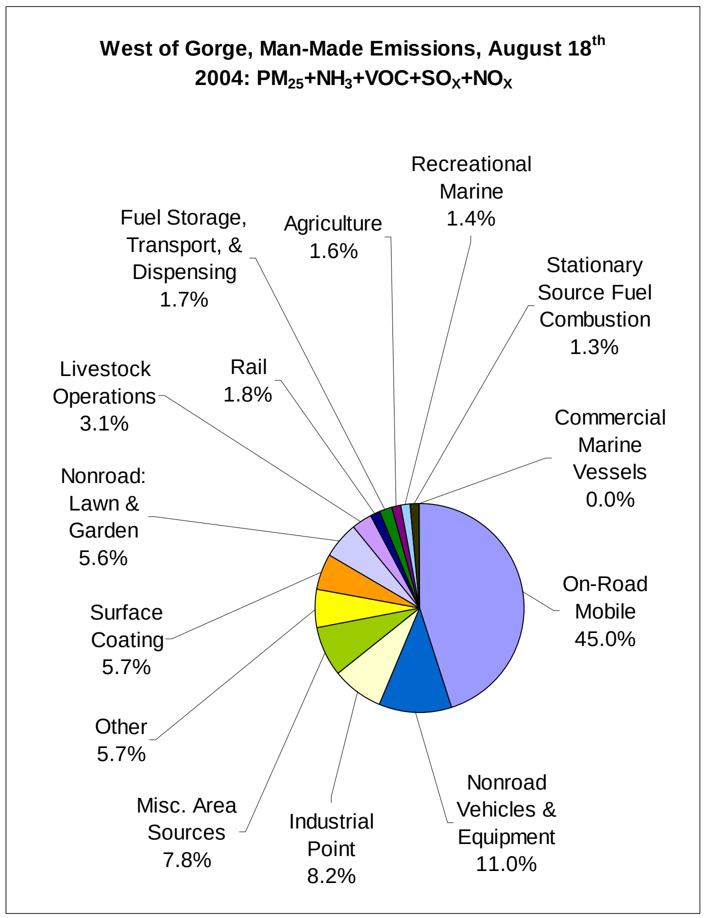
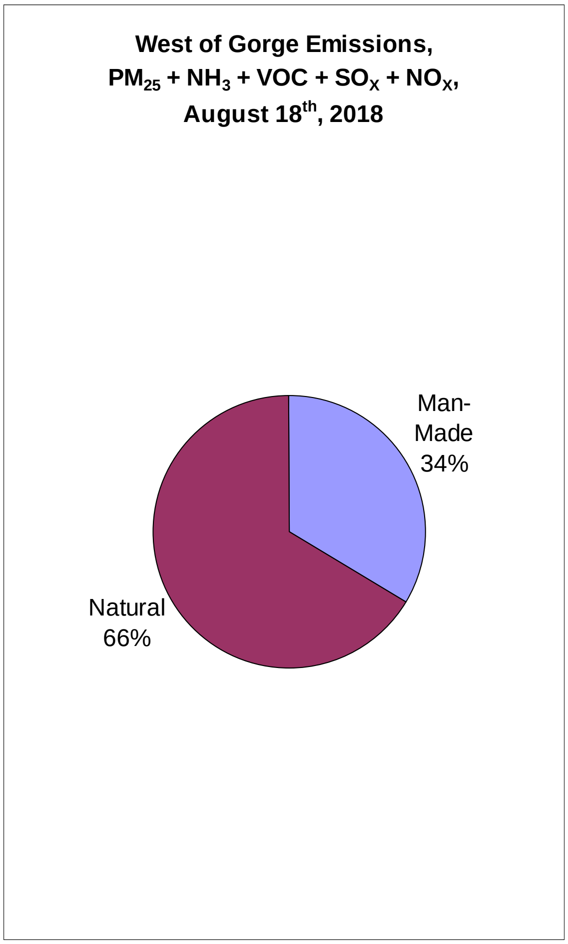


Figure 27 shows source contributions for August 18, 2018, Region 4: West of Gorge. Natural emissions are 66% and man-made emissions are 34% of the total source contribution to West of Gorge emissions. The accompanying pie chart shows the man-made emissions distributed by source category. On-road mobile and industrial point sources each account for 18%, with miscellaneous area sources, surface coating, and other each accounting for approximately 10% of the man-made source pie. The category groupings are the same as for August 2004.

Figure 27: West of Gorge Emissions, August 18, 2018



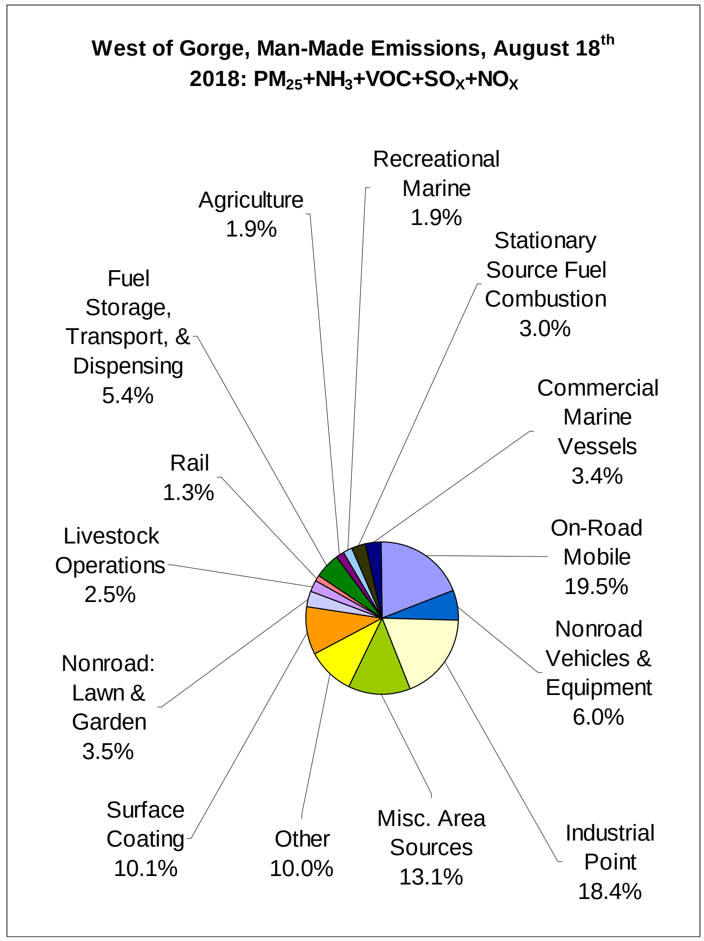


Figure 28 shows a comparison of man-made source categories in West of Gorge from August 18, 2004 to August 18, 2018. On-road mobile emissions decrease by 71% (709 tons/day to 283 tons/day), nonroad vehicles and equipment emissions decrease by 50% (174 tons/day to 87 tons/day), and nonroad: lawn and garden decrease by 43% (89 tons/day to 51 tons/day) due to EPA's ultra low sulfur fuel rules and improvements in engine manufacturing. From the chart, industrial point emissions increase by 106% (130 tons/day to 268 tons/day) and miscellaneous area sources increase by 54% (123 tons/day to 190 tons/day) based on WRAP's use of growth assumptions using EPA's Economic Growth and Analysis System growth factor model (EGAS). The "other" source category also shows some growth from 2004 to 2018, due to expected population growth and use with regards to open burning, dry cleaning and commercial food preparation.

Figure 28: West of Gorge, Man-made Emissions, August 18th

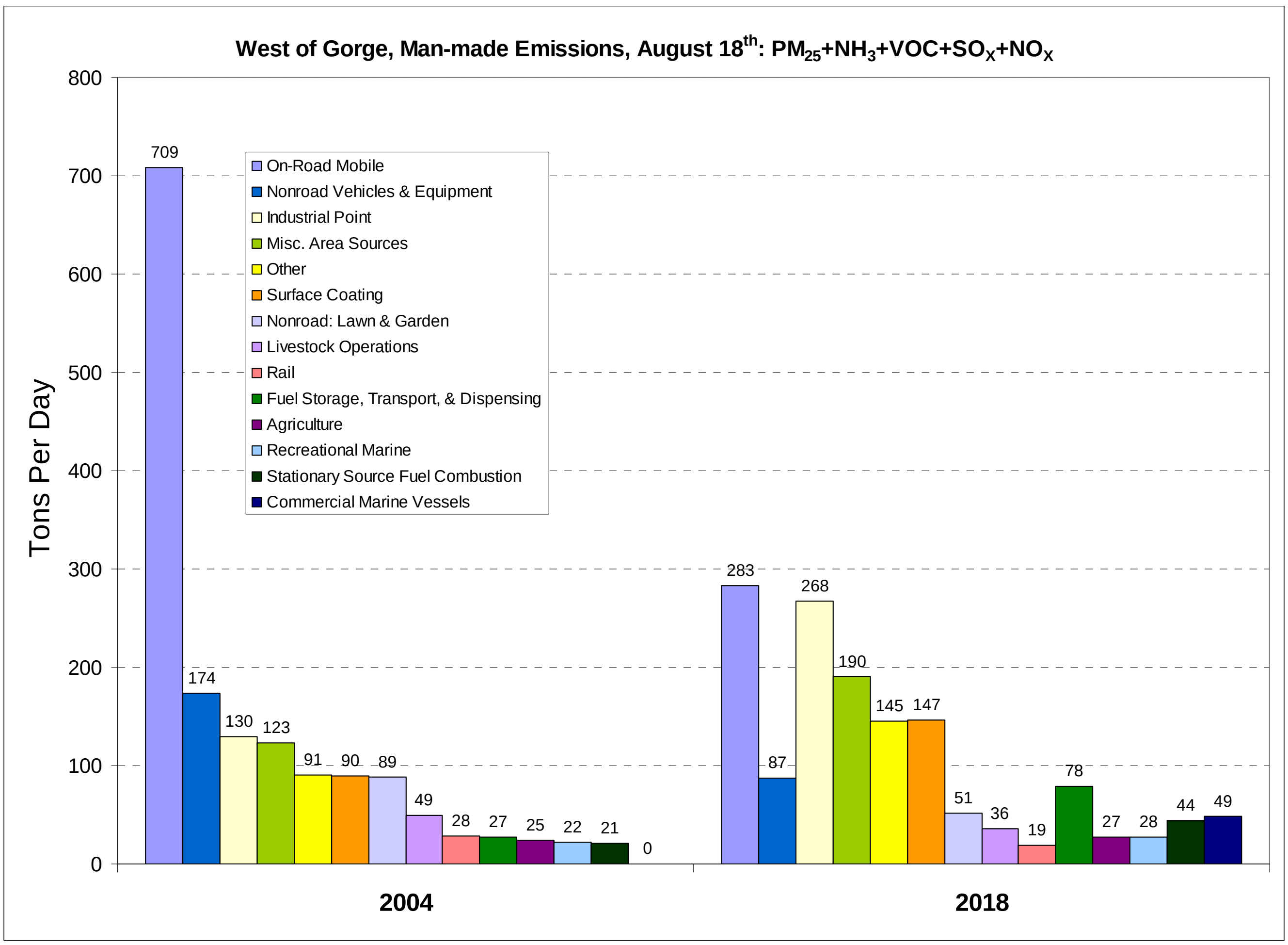
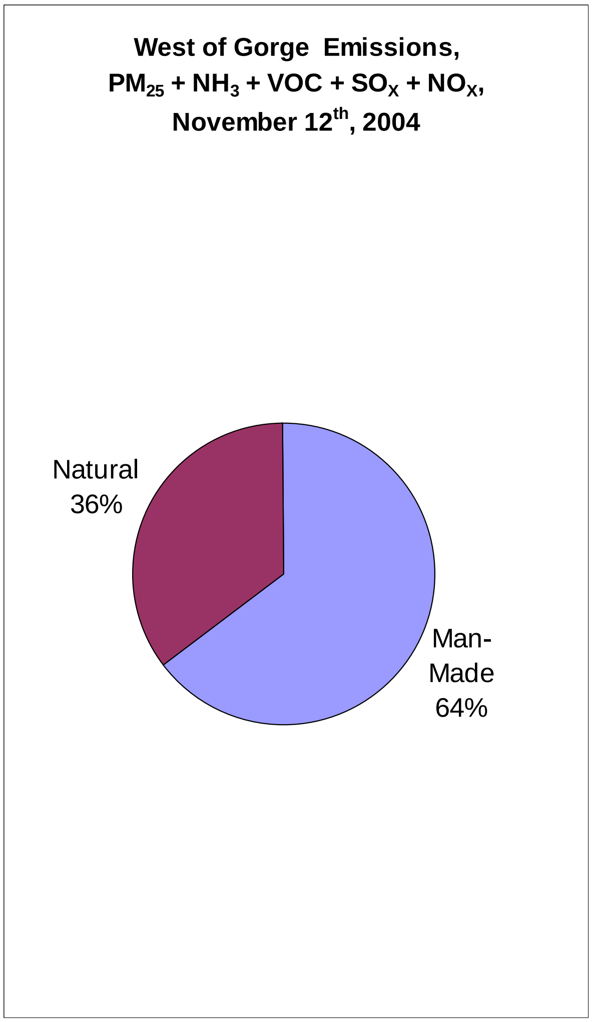


Figure 29 shows source contributions for November 12, 2004, Region 4 –West of Gorge. Man-made sources account for 64% of the overall emissions for the West of Gorge region, with natural sources comprising 36%. The accompanying pie chart shows the distribution of source categories that contribute to man-made sources. On-road mobile contributes 39% and residential wood combustion contributes 19% to man-made sources. "Misc. Area Sources" emissions include solvent use from commercial and industrial activity. The "Other" source category emissions include sewage treatment, drycleaners, and commercial food preparation.

Figure 29: West of Gorge Emissions, November 12, 2018



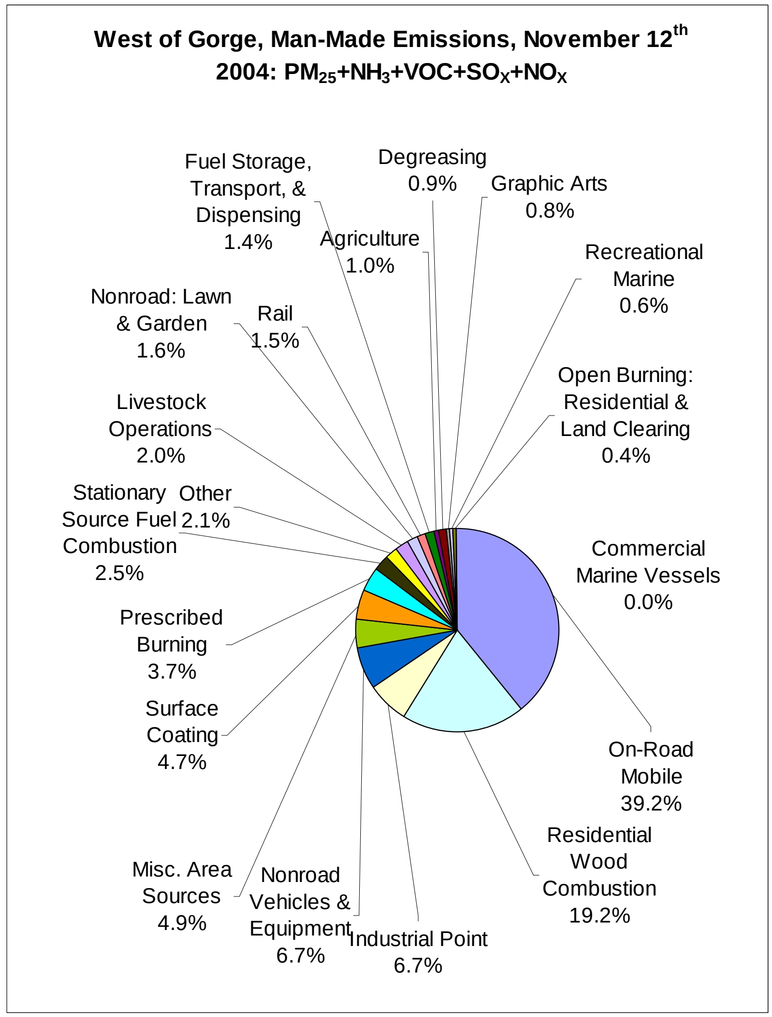
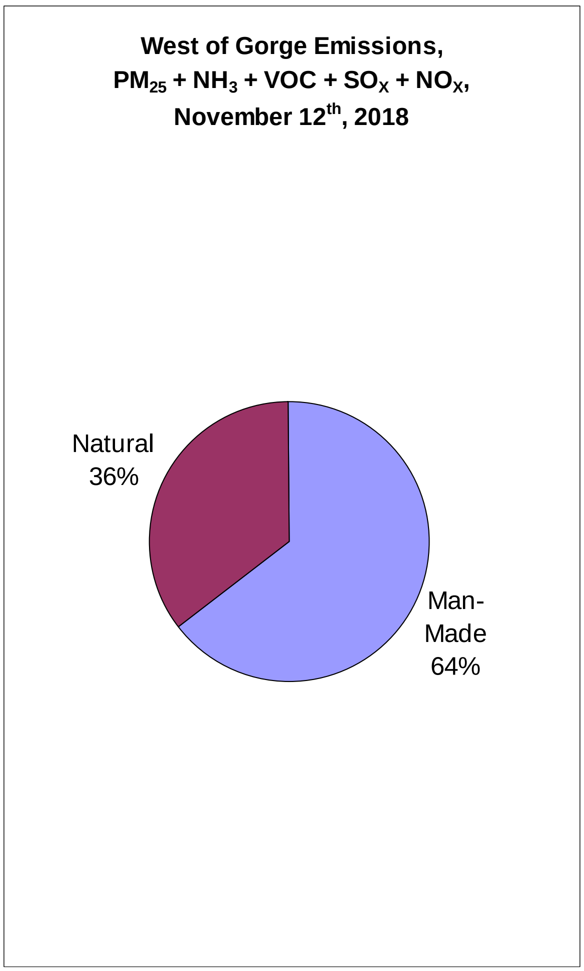


Figure 30 shows source contributions for November 12, 2018, Region 4 - West of Gorge. Man-made emissions are 64% and natural emissions are 36% of the total source contribution to West of Gorge emissions. The accompanying pie chart shows the man-made emissions distributed by source category. Residential wood combustion accounts for 20% of man-made emissions, on-road mobile emissions are 16% and industrial point source emissions are 14%. The category groupings are the same as for August 2004.

Figure 30: West of Gorge Emissions, November 12, 2018



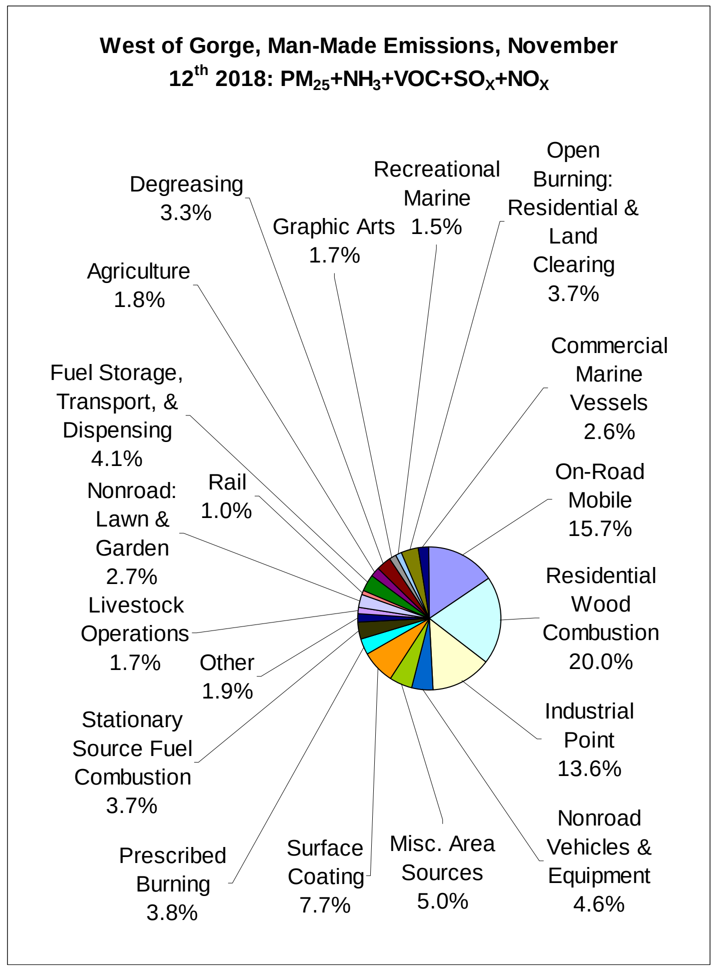
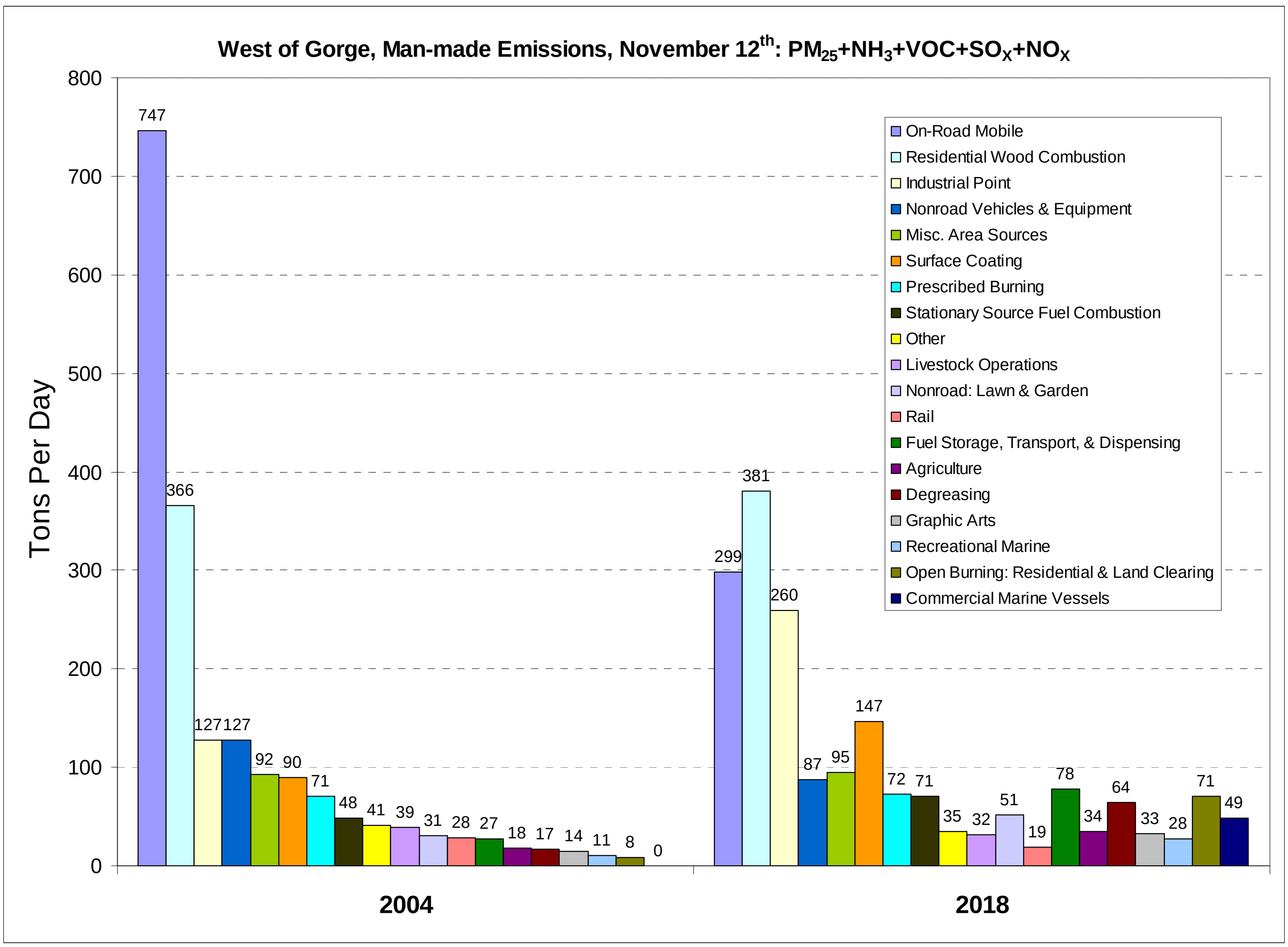


Figure 31 shows a comparison of man-made source categories in West of Gorge from November 12, 2004 to November 12, 2018. On-road mobile emissions decrease by 60% (747 tons/day to 299 tons/day) and nonroad vehicles and equipment emissions decrease by 32% (127 tons/day to 87 tons/day) due to EPA's ultra low sulfur fuel rules. Residential wood combustion remains relatively constant (366 tons/day to 381 tons/day). From the chart, industrial point emissions increase by 104% (127 tons/day to 260 tons/day), surface coating increases by 63% (90 tons/day to 147 tons/day) based on WRAP's use of growth assumptions using EPA's Economic Growth and Analysis System growth factor model (EGAS). Additionally, as the population increases, categories that are contingent upon population increase also show an increase in emissions including fuel storage and transport, stationary fuel source combustion, residential and land clearing open burning.

Figure 31: West of Gorge, Man-made Emissions, November 12th

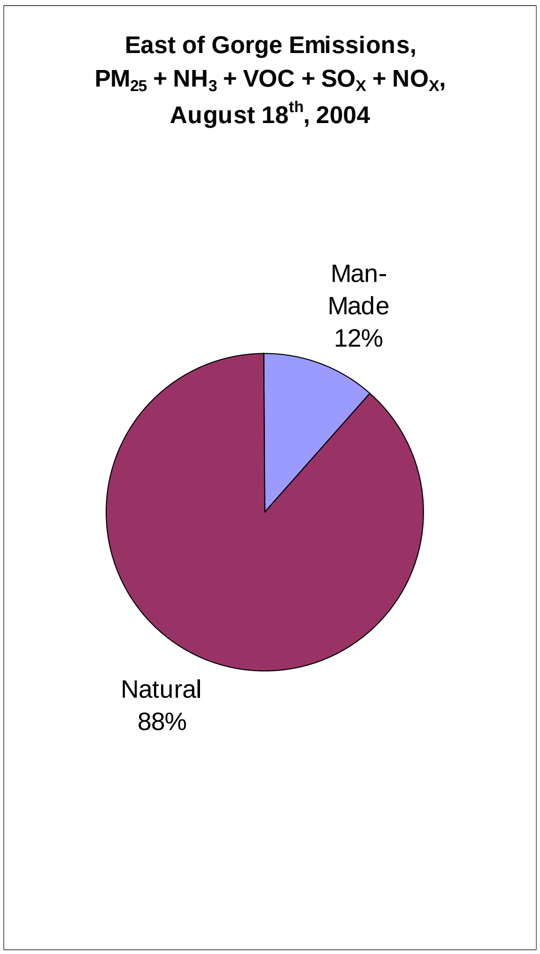


E. East of Gorge Source Contribution

The East of Gorge area (Region 5) comprises all other areas east of the Cascades. As with the In-Gorge source category emissions, the source categories were determined by identifying all the man-made source categories that contribute to East of Gorge area emissions. DEQ identified and grouped these categories according to similar category groupings (e.g. the agricultural source category consists of nonroad – agricultural, fertilizer operations, and orchard heaters, etc.), the amount of emissions for each category, and source categories of interest. For further information on how the man-made emission source categories were grouped, please refer to Appendix A.

Figure 32 shows source contributions for August 18, 2004, Region 5: East of Gorge. Natural sources account for 88% of the overall emissions for the East of Gorge region, with man-made sources comprising 12%. The accompanying pie chart shows the distribution of source categories that contribute to man-made sources. On-road mobile and agriculture each contribute almost 25%, and industrial point emissions contribute 12% to man-made sources. The "Other" category emissions include landfills, residential wood combustion, open and prescribed burning, etc. In this chart, "Livestock operations" is its own category, separate from "Agriculture" emissions because of its significance in the eastern part of the Gorge.

Figure 32: East of Gorge Emissions, August 18, 2004



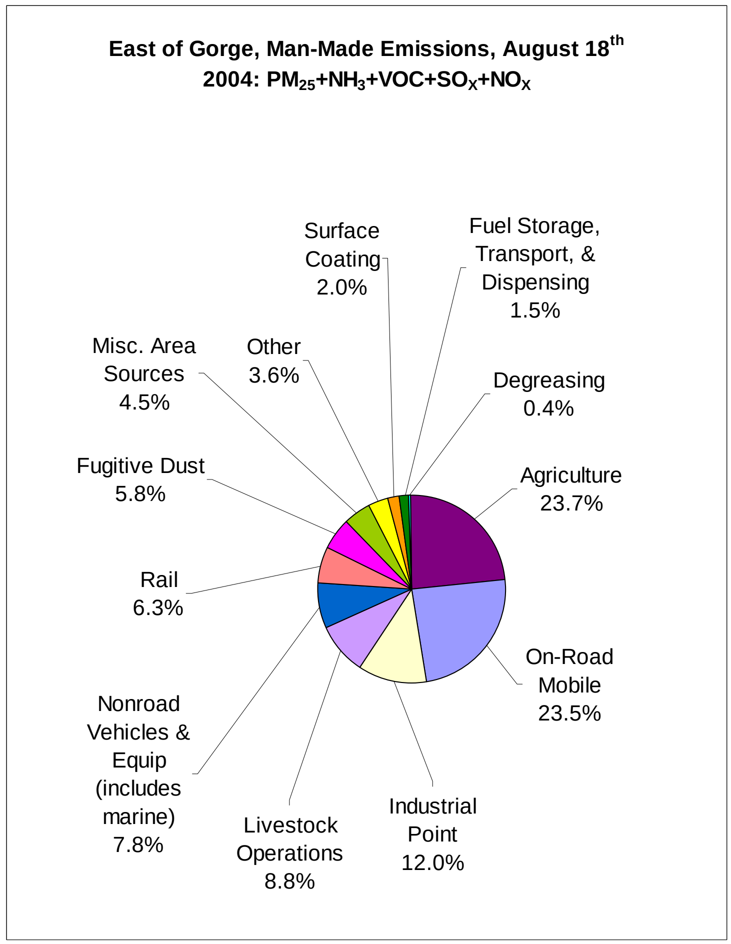
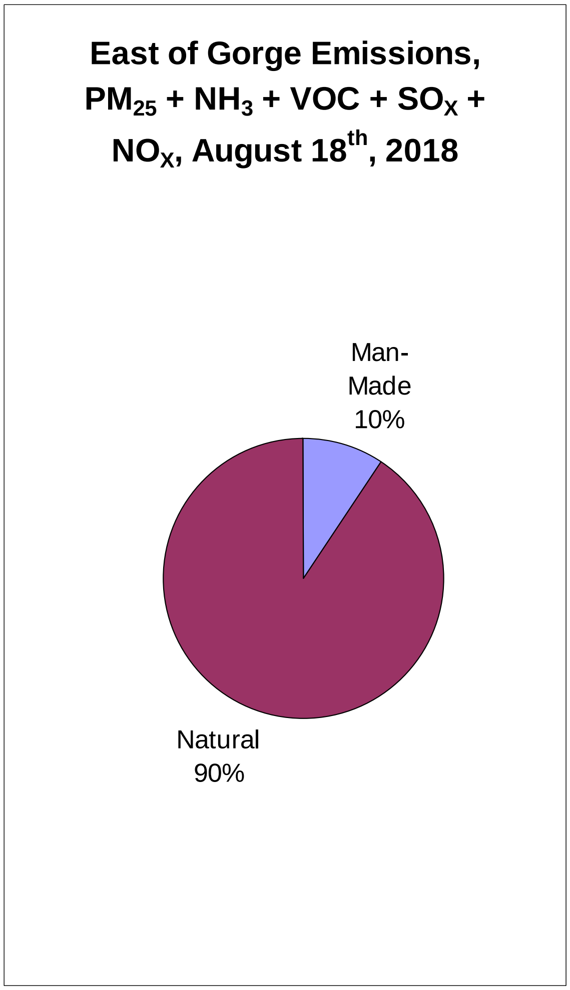


Figure 33 shows source contributions for August 18, 2018, Region 5 - East of Gorge. Natural emissions are 90% and man-made emissions are 10% of the total source contribution to East of Gorge emissions. The accompanying pie chart shows the man-made emissions distributed by source category. Agriculture emissions account for 28%, with on-road mobile emissions contributing 12% and industrial point emissions contributing 16%. The category groupings are the same as for August 2004.

Figure 33: East of Gorge Emissions, August 18, 2018



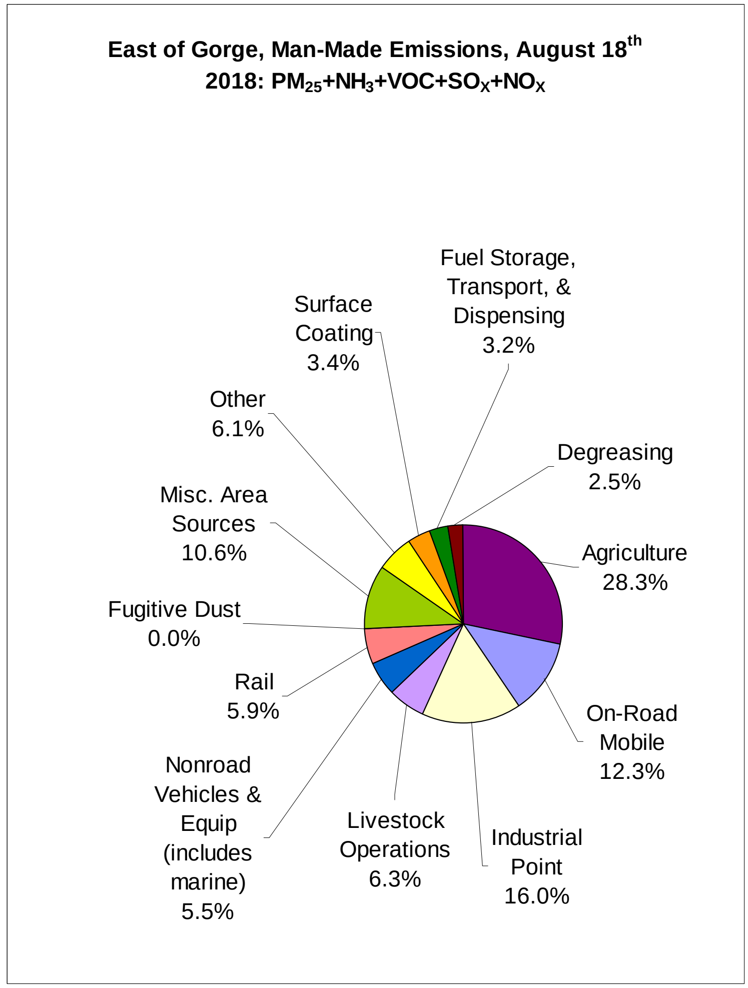


Figure 34 shows a comparison of man-made source categories in East of Gorge from August 18, 2004 to August 18, 2018. On-road mobile emissions decrease by 58% (220 tons/day to 93 tons/day) due to EPA's ultra low sulfur fuel rules. Industrial point emissions and agriculture emissions remain constant. Livestock operations emissions decrease by 43% (83 tons/day to 48 tons/year) and nonroad vehicles and equipment (including marine emissions) decrease by 44% (73 tons/year to 41 tons/year). Fugitive dust emissions are nonexistent in 2018, potentially as a result of an EI error. Miscellaneous area source emissions increase by 90% (42 tons/year to 80 tons/year) due to projections from EPA's EGAS model. As the population increases, categories that are contingent upon population increase also show an increase in emissions including fuel storage and transport and degreasing.

Figure 34: East of Gorge, Man-made Emissions, August 18th

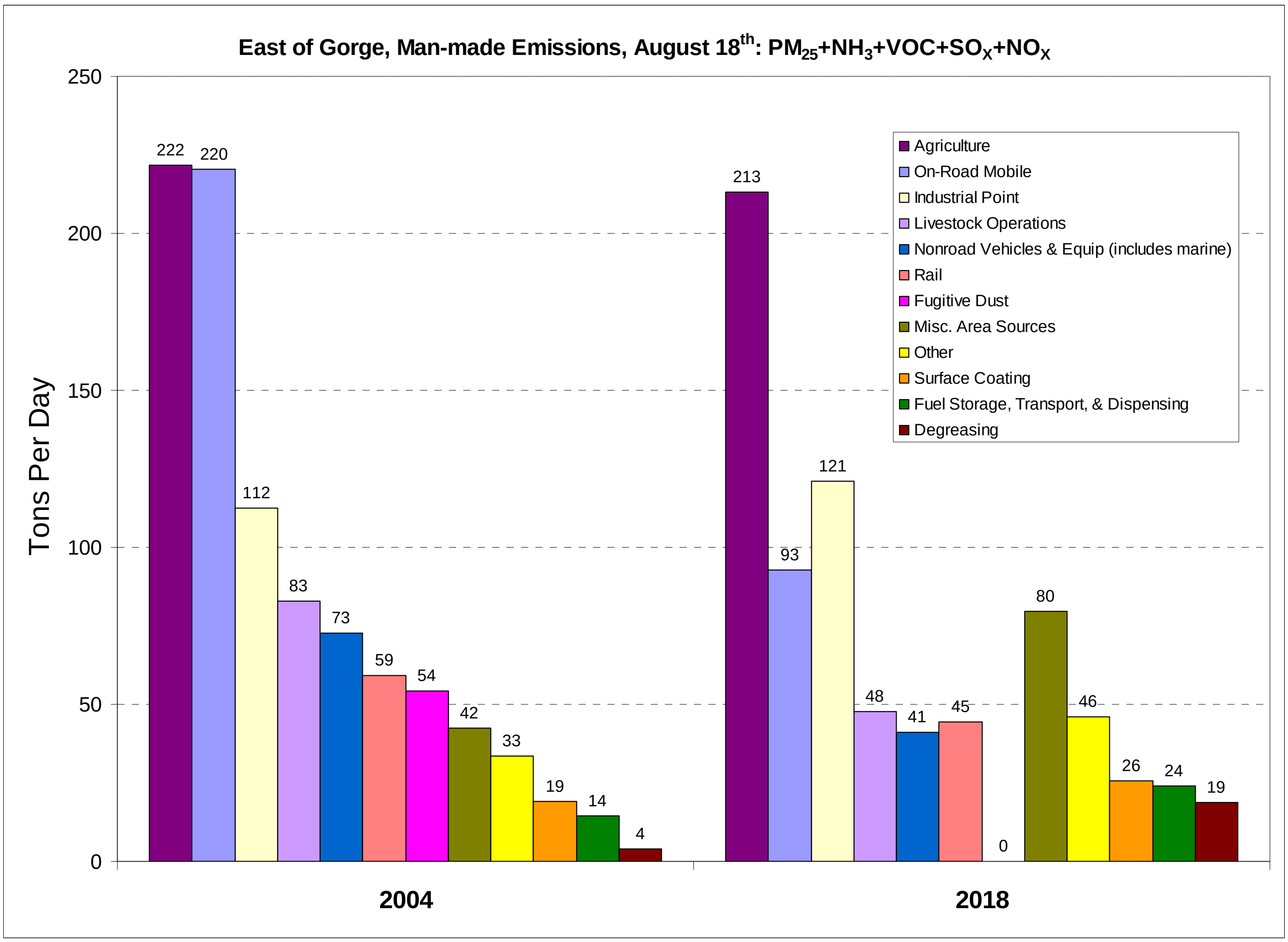
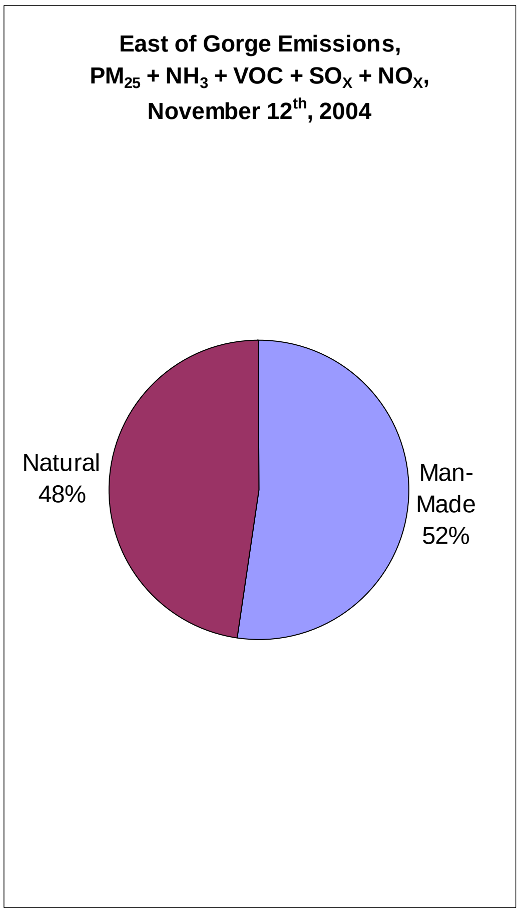


Figure 35 shows source contributions for November 12, 2004, Region 5: East of Gorge. Man-made sources account for 52% of the overall emissions for East of Gorge region, with natural sources comprising 48%. The accompanying pie chart shows the distribution of source categories that contribute to man-made sources. Prescribed burning and on-road mobile each contribute 18% and 24% respectively, industrial point and residential wood combustion emissions combined contribute 21% to man-made sources. The "Other" category emissions include landfills, stationary fuel combustion, and incineration, etc. In this chart, "Livestock operations" is its own category, separate from "Agriculture" emissions.

Figure 35: East of Gorge Emissions, November 12, 2004



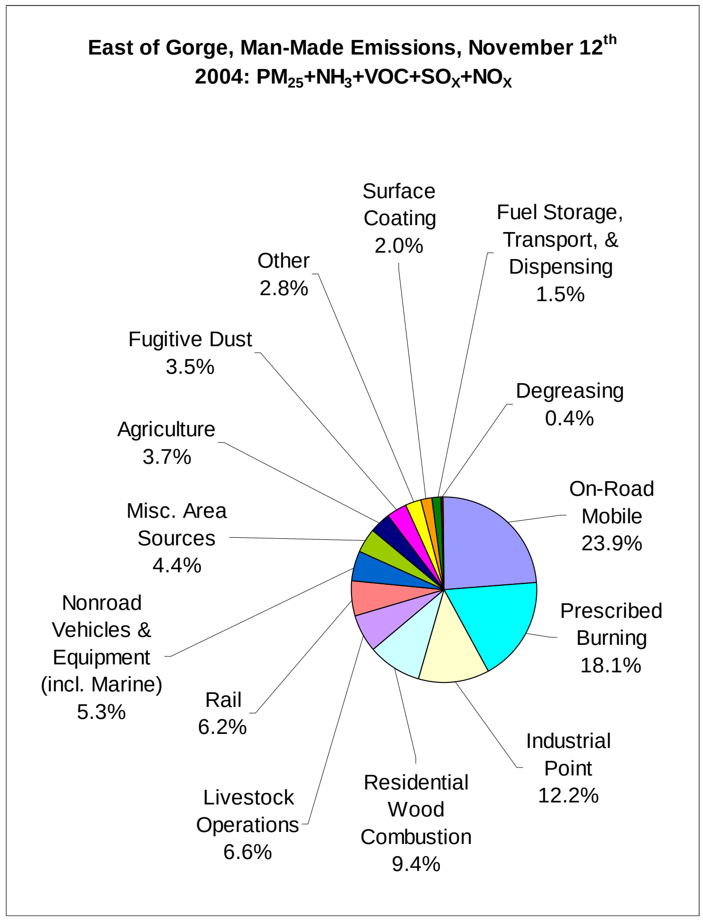
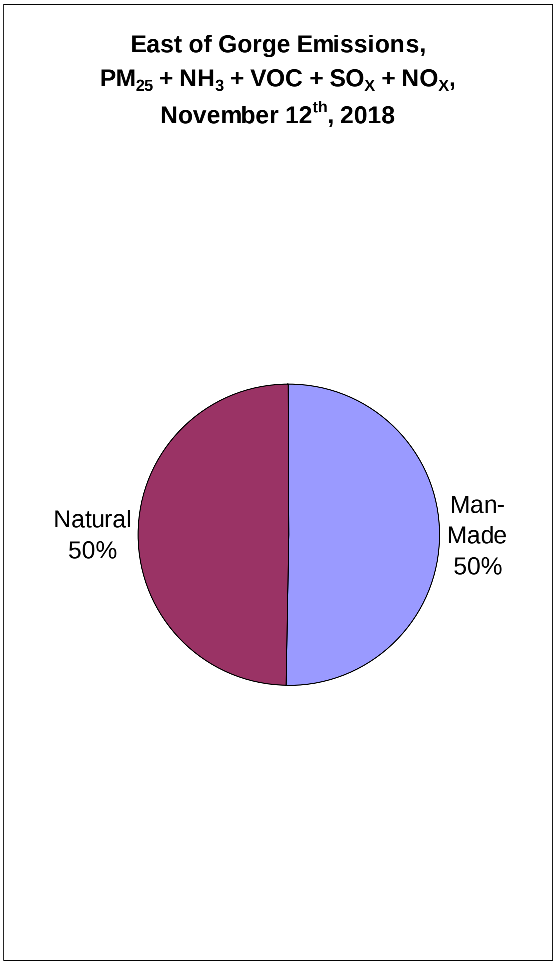


Figure 36 shows source contributions for November 12, 2018, Region 5 - East of Gorge. Natural emissions are 50% and man-made emissions are 50% of the total source contribution to East of Gorge emissions. The accompanying pie chart shows the man-made emissions distributed by source category. Prescribed burning contributes 19% of emissions, with industrial point sources, residential wood combustion, and on-road mobile totaling 35% of the contribution to the man-made source pie. The category groupings are the same as for August 2004.

Figure 36: East of Gorge Emissions, November 12, 2018



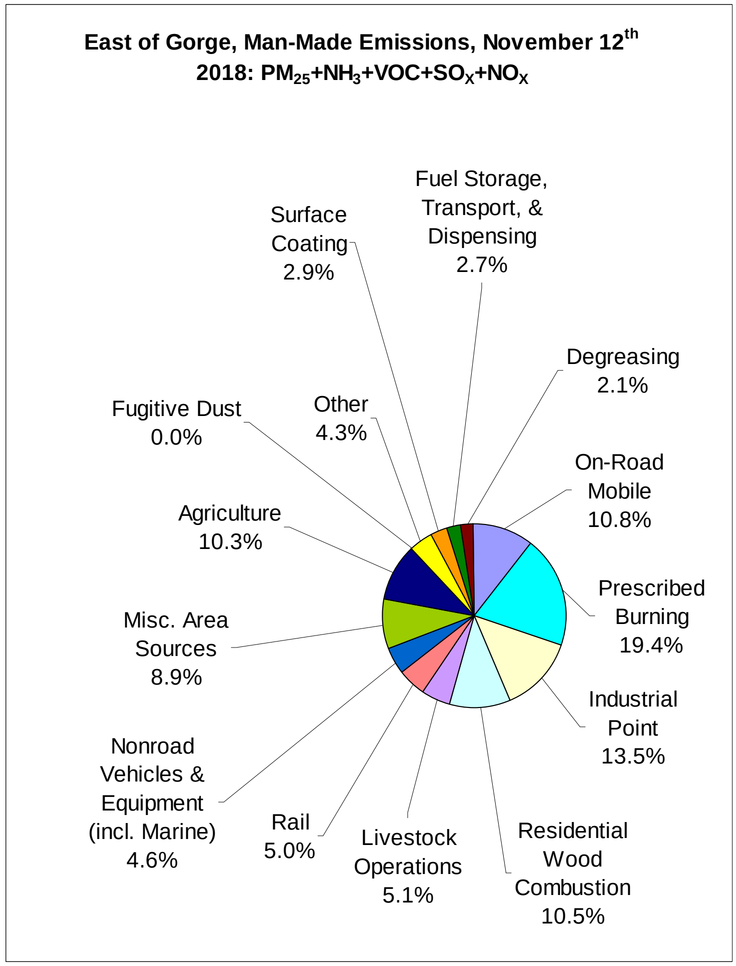
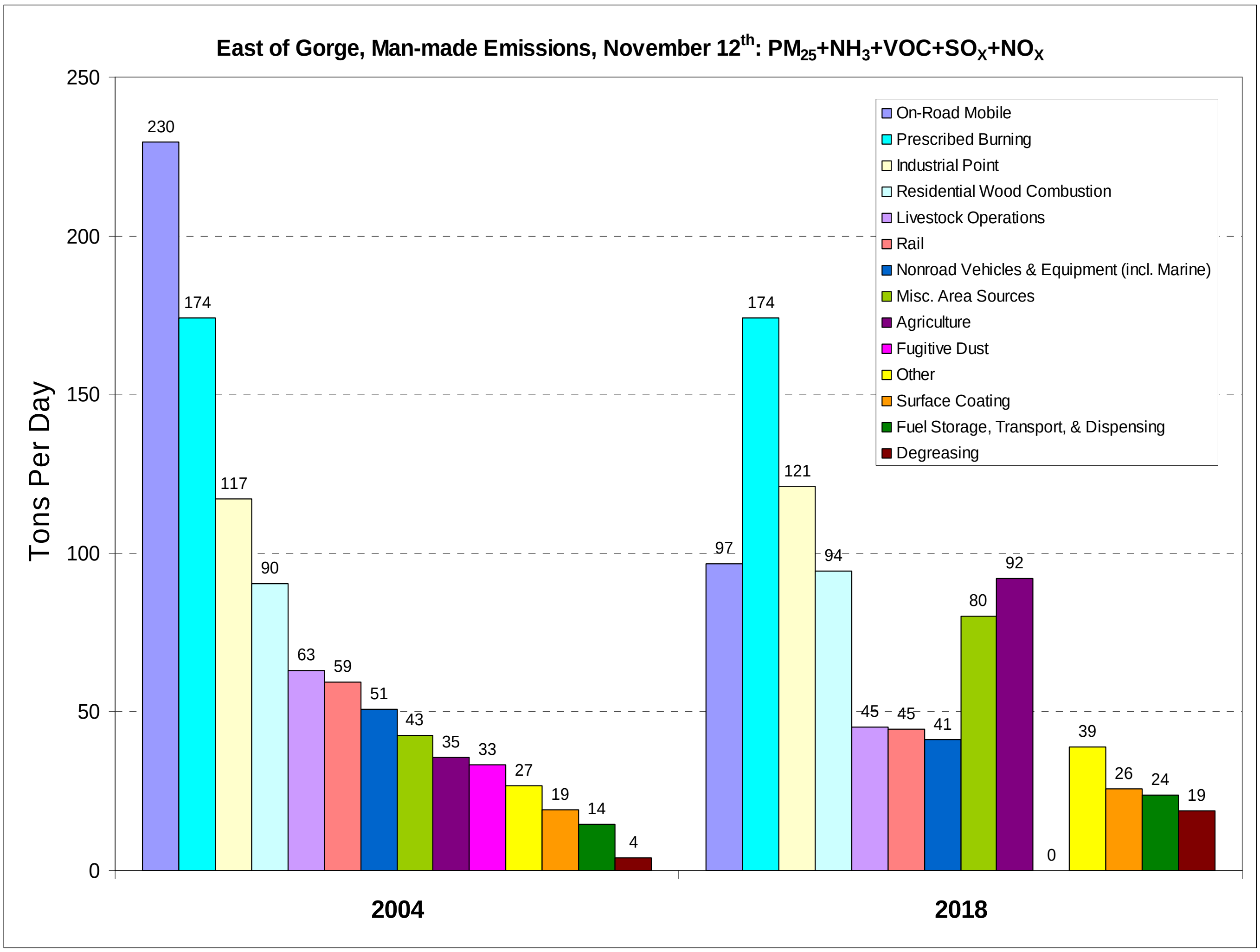


Figure 37 shows a comparison of man-made source categories in East of Gorge from November 12, 2004 to November 12, 2018. On-road mobile emissions decrease by 58% (230 tons/day to 97 tons/day) due to EPA's ultra low sulfur fuel rules. Prescribed burning, industrial point emissions and residential wood combustion emissions remain constant. "Other" source category emissions increase, due to landfills and open burning. Fugitive dust emissions are nonexistent in 2018, potentially as a result of an EI error. Agriculture emissions increase as well, but it could be due to a temporal EI error. Miscellaneous area sources increase by 86% (43 tons/day to 80 tons/day) due to projected emissions calculated from EPA's EGAS model.

Figure 37: East of Gorge, Man-made Emissions, November 12th



VII. Domain Emissions by Pollutant

To better understand the relative contribution of pollutants over the entire domain, the emissions were grouped to show how much the pollutants contribute relative to one another, and the proportion of natural versus man-made sources. The charts in this chapter provide a look at the individual pollutants, particularly those that cause visibility impairment - SOx, NOx, and PM2.5. While still significant, VOC and NH3 are also pollutants of concern, but do not directly cause visibility impairment. Additionally, the charts provide an overall snapshot of pollutant emissions for the two modeled episodes modeled and the main source categories of both natural and man-made emissions.

A. SOx

Figures 38-41 show the distribution of SOx emissions over the modeling domain. For the August 18, 2004, **Figure 38** shows the breakdown of natural vs. man made SOx sources for the 4-km domain. SOx is 3% of the pollutant contribution for the domain, and of that natural sources are responsible for 59% and man-made sources for 41%. The charts are further distributed to show the composition of SOx natural sources and man-made sources. Wildfires are the sole contributor (100%) to the natural source component of SOx. Point sources contribute 24% of the total SOx emissions. Coal fired boilers are 38% of the man-made sources, but contribute 16% of the total SOx emissions. Nonroad sources (26%) contribute to 11% of the total SOx emissions.

Figure 38: SOx Domain Emissions - August 18, 2004

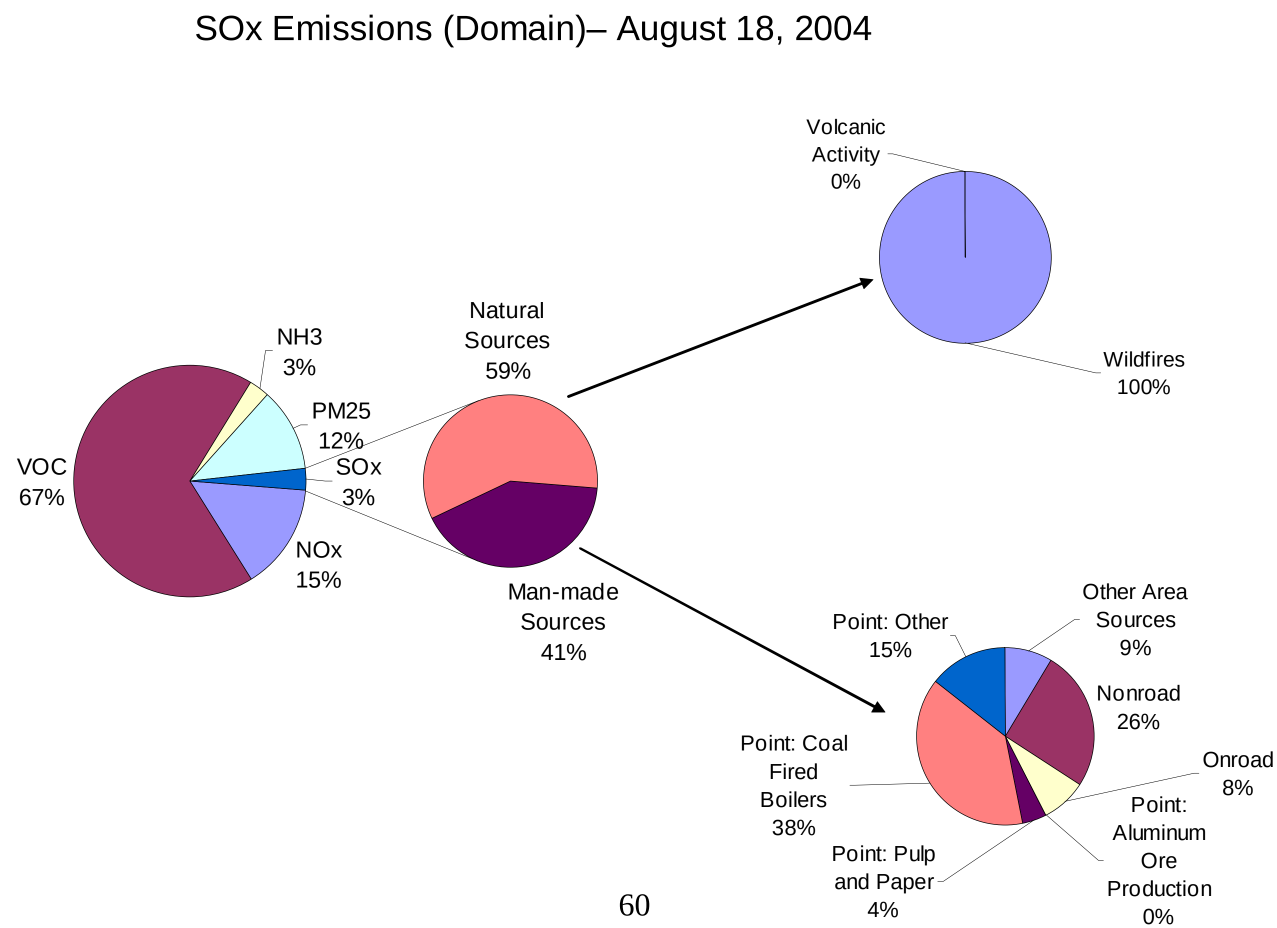
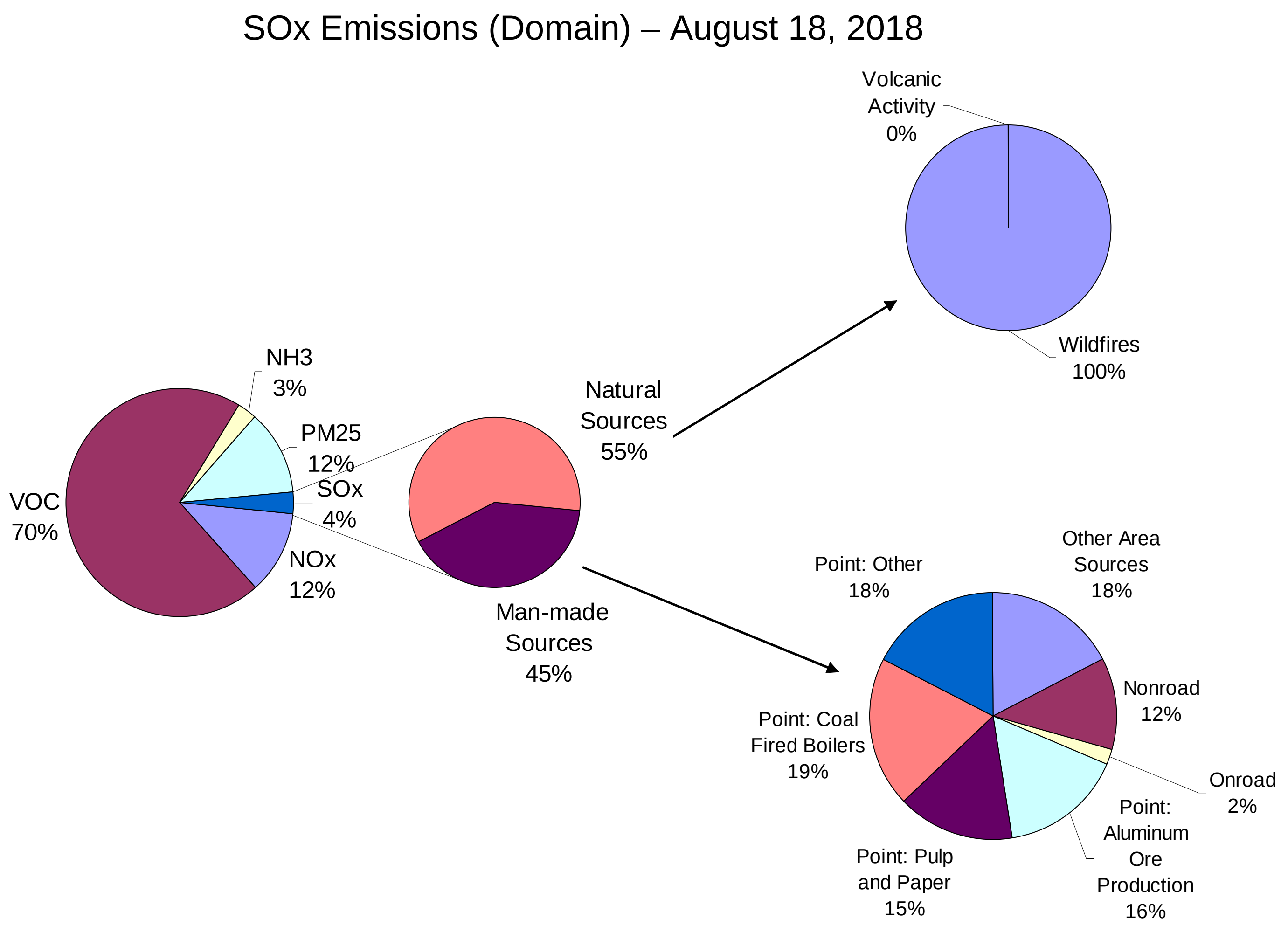


Figure 39 shows the breakdown of natural vs. man-made SOx sources for the August 18, **2018** episode. SOx emissions are 4% of the pollutant emissions for the whole domain, with natural sources comprising the majority of that contribution (55%) and man-made sources contributing 45%. Wildfires are the sole contributor (100%) to the natural source component of SOx. For all the man-made sources, all point sources contribute 68% of the total SOx emissions. Coal fired boilers contribute 9% of the total SOx emissions. Other area sources contribute 8% of the total SOx emissions.

Figure 39: SOx Domain Emissions - August 18, 2018



For November 12, 2004, **Figure 40** shows the breakdown of natural vs. man made SOx sources for the whole domain. SOx is 8% of the pollutant contribution for the domain, and of that natural sources are 43% of the SOx contribution and man-made sources comprise 57%. The charts are further distributed to show the composition of SOx natural sources and man-made sources. Volcanic activity is the sole contributor (100%) to the natural source component of SOx. For all the man-made sources, all the point sources contribute 52% of the total SOx emissions. Coal fired boilers are 35% of the man-made source contribution, but are 20% of the total SOx emissions. Other area sources (24%) contribute 14% of the total SOx emissions.

Figure 40: SOx Domain Emissions - November 12, 2004

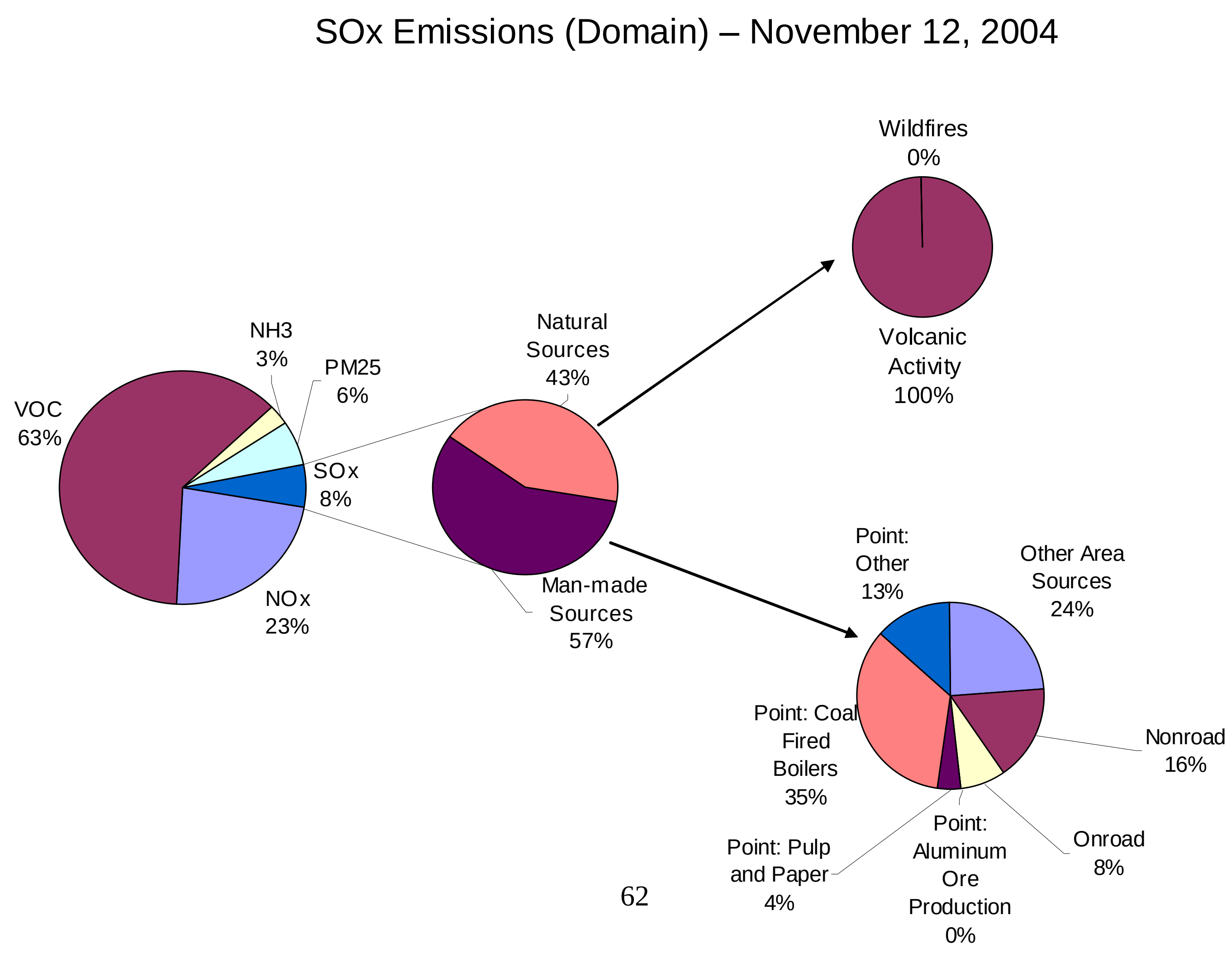
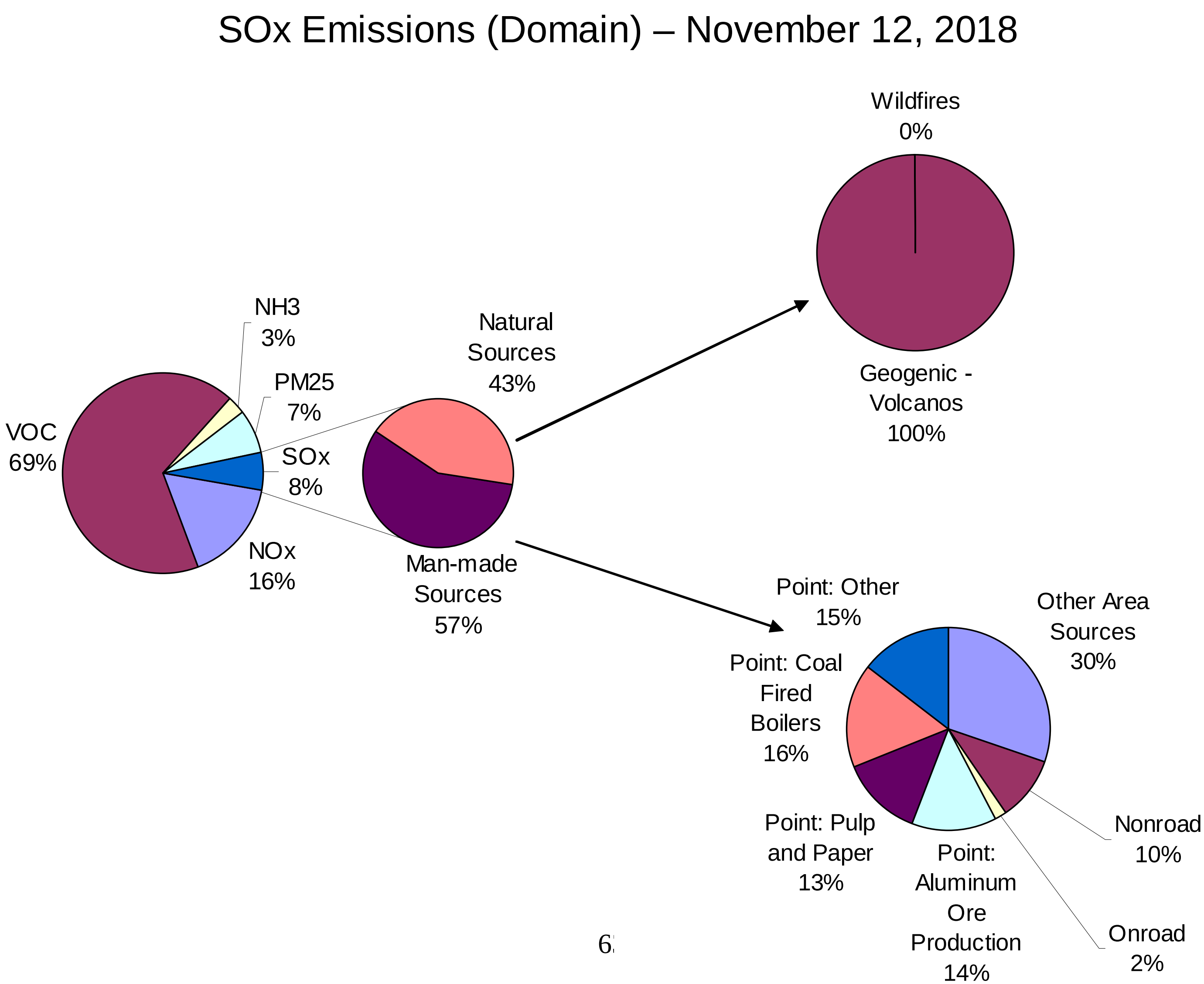


Figure 41 shows the breakdown of natural vs. man-made SOx sources for the November 12, **2018** episode. SOx emissions are 8% of the pollutant emissions for the whole domain, with man-made sources comprising the majority of that contribution (57%) and natural sources contributing 43%. Volcanic activity is the sole contributor (100%) to the natural source component of SOx. For all the man-made sources, all point sources contribute 58% of the total SOx emissions. Coal fired boilers contribute 9% of the total SOx emissions and other area sources contribute 17% of the total SOx emissions.

Figure 41: SOx Domain Emissions - November 12, 2018



B. NOx

Figures 42-45 show the distribution of NOx emissions over the modeling domain. For the August 18, 2004, **Figure 42** shows the breakdown of natural vs. man made NOx sources for the whole domain. NOx is 15% of the pollutant contribution for the domain, and of that man-made sources are 62% of the NOx contribution and natural sources comprise 38%. The charts are further distributed to show the composition of NOx natural sources and man-made sources. Wildfires contribute 73% and natural sources (as it is defined by its SCC classification) contribute 27% to the natural source component of NOx. For all the man-made sources, on-road emissions are 52% of the man-made source contribution and are 32% of the total NOx emissions. Nonroad sources (31%) contribute 19% of the total NOx emissions.

Figure 42: NOx Domain Emissions - August 18, 2004

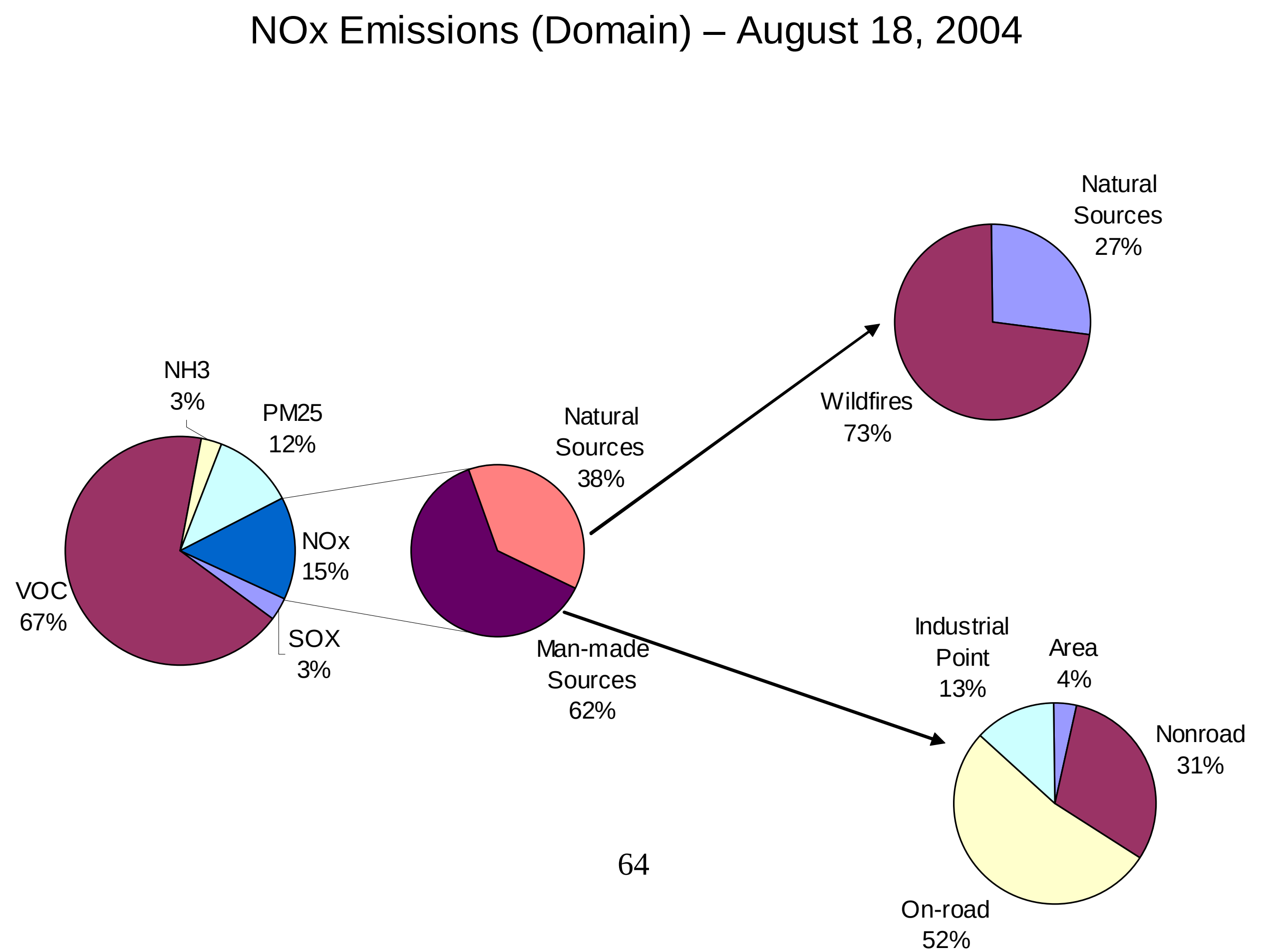
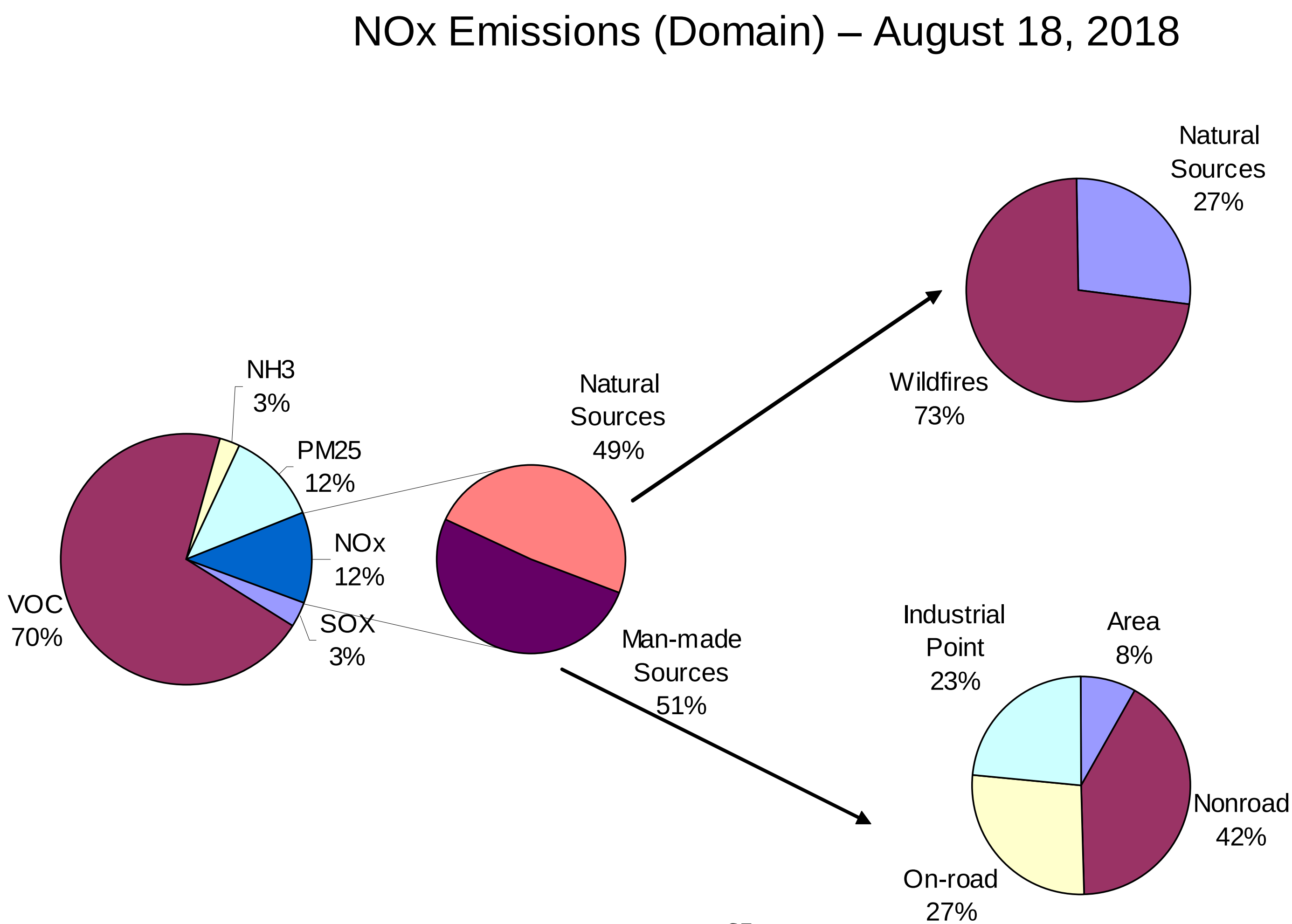


Figure 43 shows the breakdown of natural vs. man-made NOx sources for the August 18, **2018** episode. NOx emissions are 12% of the pollutant emissions for the whole domain, with man-made sources comprising the majority of that contribution (51%) and natural sources contributing 49%. Wildfires contribute 73% and natural sources (as it is defined by its SCC classification) contribute 27% to the natural source component of NOx. For all the man-made sources, nonroad emissions are 42% of the man-made source contribution and are 21% of the total NOx emissions. Onroad sources (27%) contribute 14% of the total NOx emissions.

Figure 43: NOx Domain Emissions - August 18, 2018



For the November 12, 2004 episode, **Figure 44** shows the breakdown of natural vs. man made NOx sources for the whole domain. NOx is 23% of the pollutant contribution for the domain, and of that man-made sources are 94% of the NOx contribution and natural sources comprise 6%. The charts are further distributed to show the composition of NOx natural sources and man-made sources. “Natural sources” are the sole contributor (100%) to the natural source component of NOx. For all the man-made sources, on-road emissions are 56% of the man-made source contribution and are 53% of the total NOx emissions. Nonroad sources (20%) contribute 19% of the total NOx emissions.

Figure 44: NOx Domain Emissions - November 12, 2004

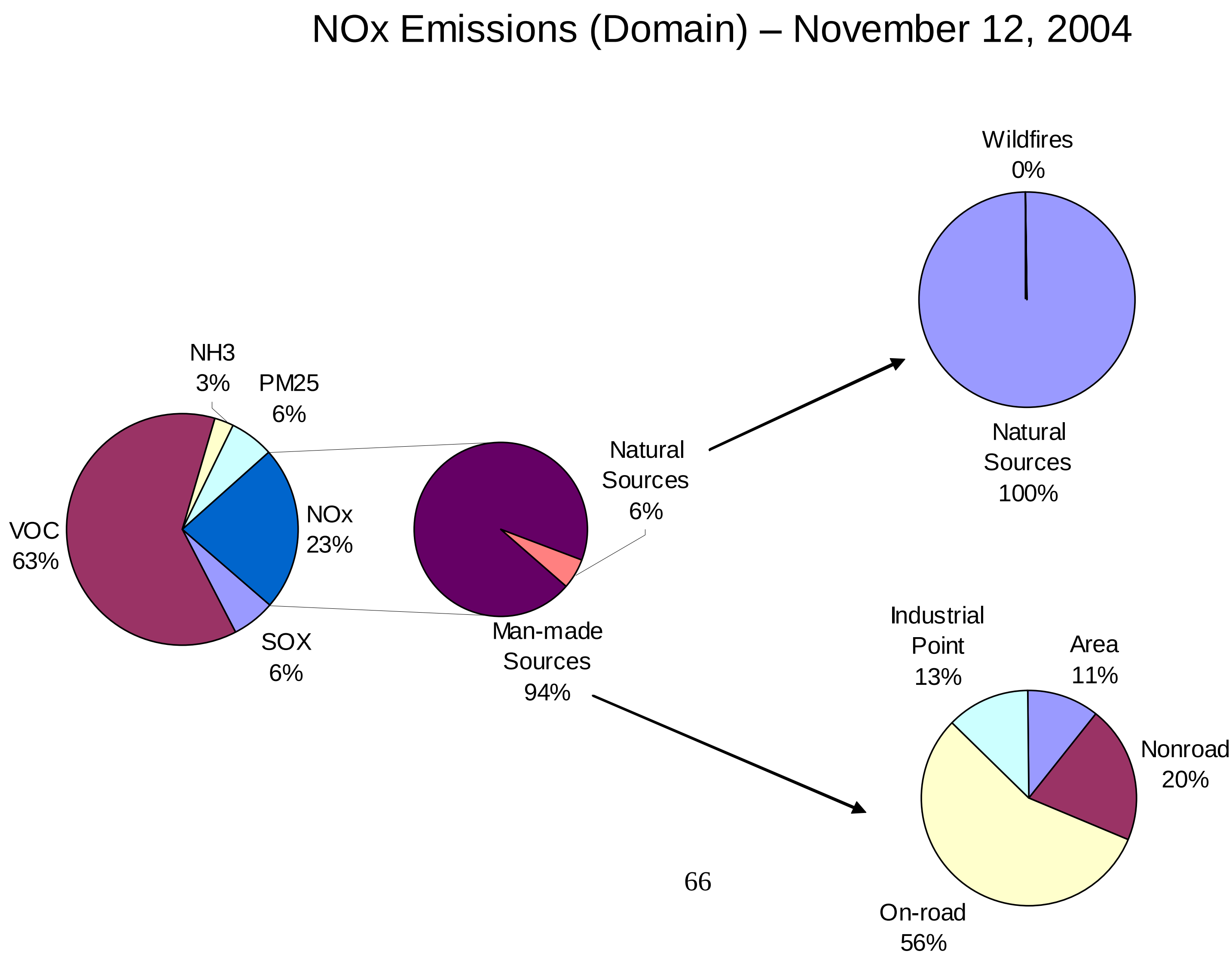
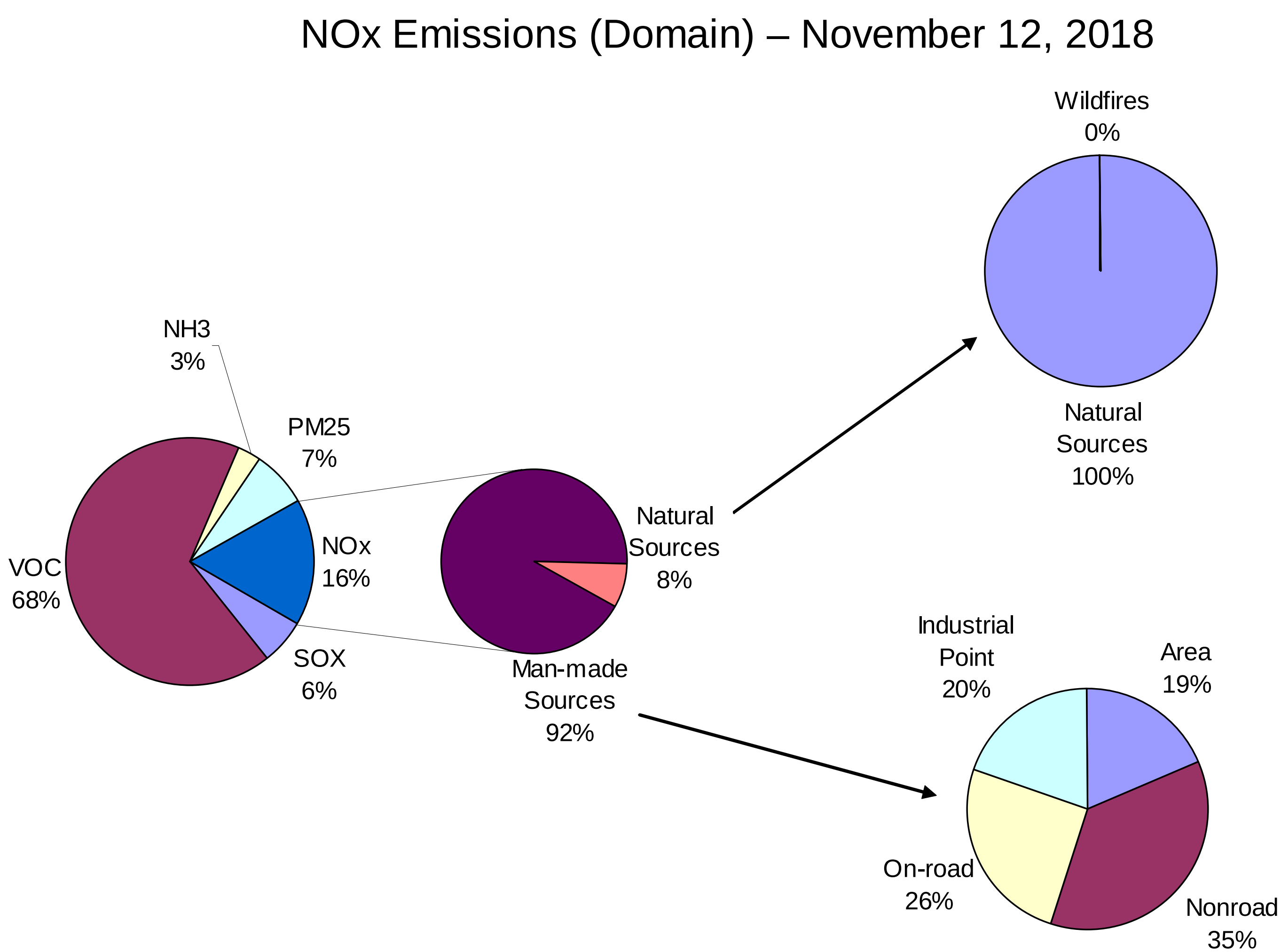


Figure 45 shows the breakdown of natural vs. man-made NOx sources for the November 12, **2018** episode. NOx emissions are 16% of the pollutant emissions for the whole domain, with man-made sources comprising the majority of that contribution (92%) and natural sources contributing 8%. "Natural sources" are the sole contributor (100%) to the natural source component of NOx. For all the man-made sources, nonroad emissions are 35% of the man-made source contribution and are 32% of the total NOx emissions. On-road sources (26%) contribute 24% of the total NOx emissions.

Figure 45: NOx Domain Emissions - November 12, 2018



C. VOC

Figures 46-49 show the distribution of VOC emissions over the modeling domain. For the August 18, 2004, **Figure 46** shows the breakdown of natural vs. man made VOC sources for the whole domain. VOC is 67% of the pollutant contribution for the domain, and of that natural sources are 85% of the VOC contribution and man-made sources comprise 15%. The charts are further distributed to show the composition of VOC natural sources and man-made sources. "Natural sources" are the sole contributor (100%) to the natural source component of VOC. For all the man-made sources, area source emissions are 70% of the man-made source contribution and are 11% of the total VOC emissions. On-road sources (16%) contribute 2.4% of the total VOC emissions.

Figure 46: VOC Domain Emissions - August 18, 2004

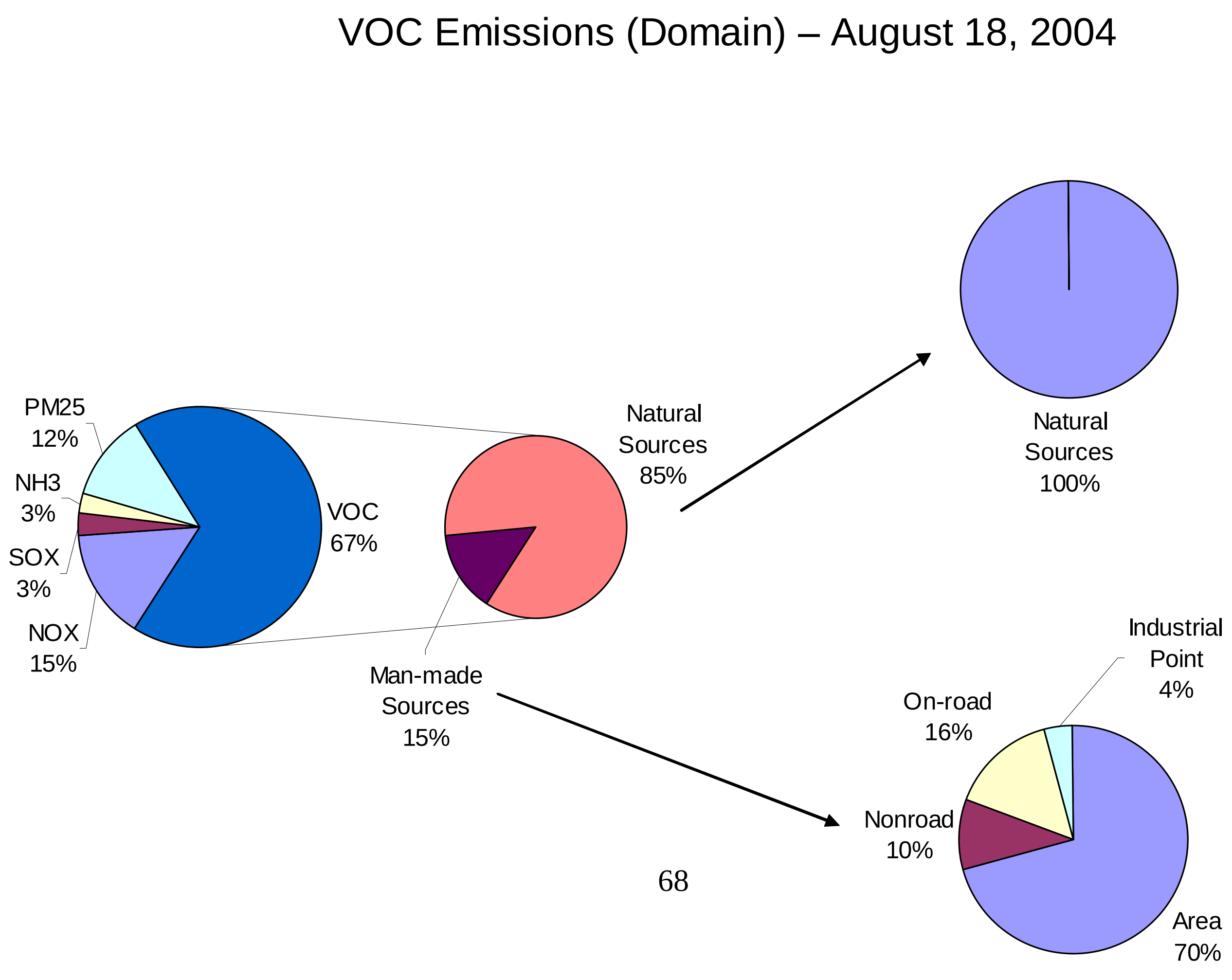
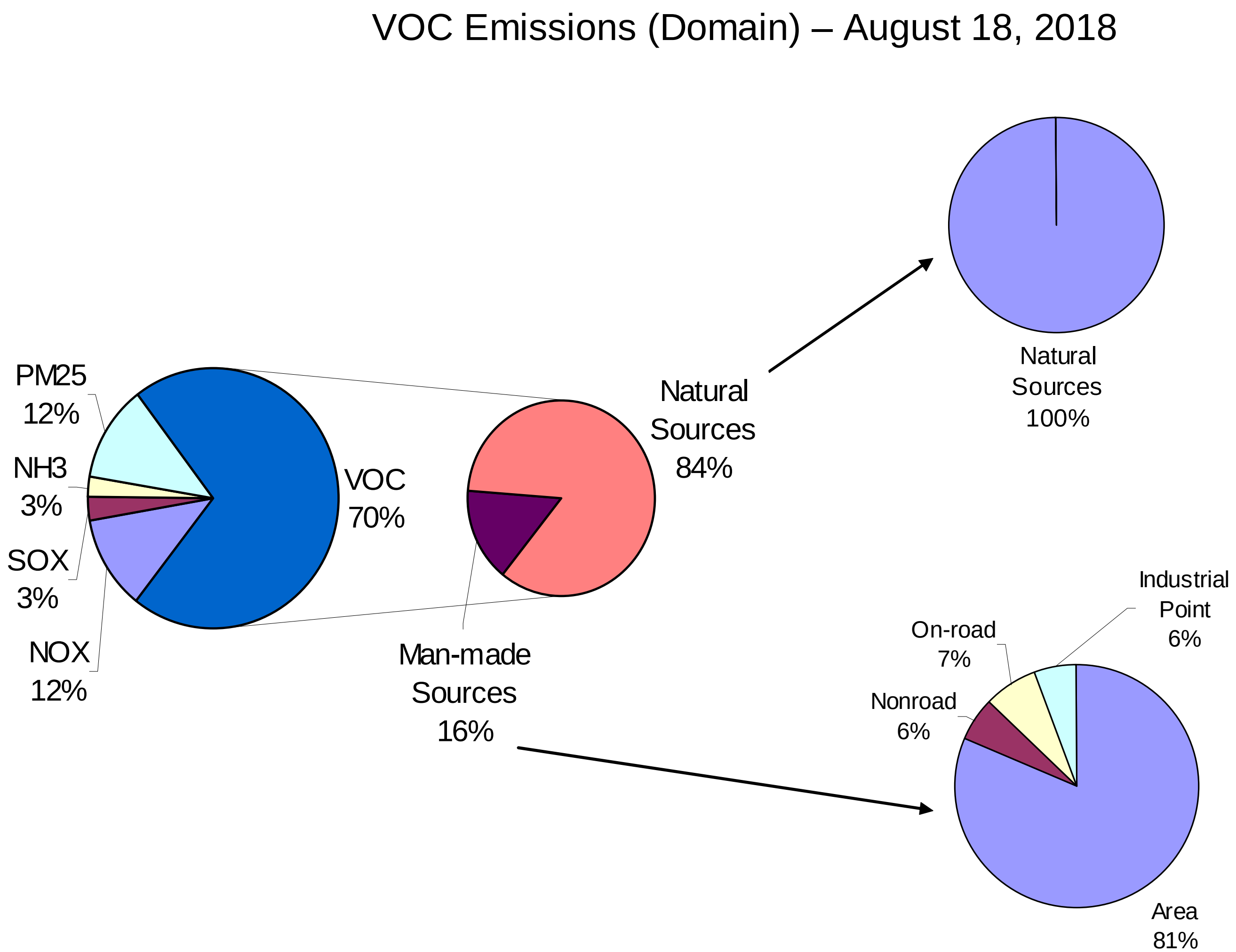


Figure 47 shows the breakdown of natural vs. man-made VOC sources for the August 18, **2018** episode. VOC emissions are 70% of the pollutant emissions for the whole domain, with natural sources comprising the majority of that contribution (84%) and man-made sources contributing 16%. "Natural sources" are the sole contributor (100%) to the natural source component of VOC. For all the man-made sources, area source emissions are 81% of the man-made source contribution and are 13% of the total VOC emissions. On-road sources (7%) contribute 1.1% of the total VOC emissions.

Figure 47: VOC Domain Emissions - August 18, 2018



For the November 12, 2004, **Figure 48** shows the breakdown of natural vs. man made VOC sources for the whole domain. VOC is 61% of the pollutant contribution for the domain, and of that natural sources are 55% of the VOC contribution and man-made sources comprise 45%. The charts are further distributed to show the composition of VOC natural sources and man-made sources. "Natural sources" are the sole contributor (100%) to the natural source component of VOC. For all the man-made sources, area source emissions are 58% of the man-made source contribution and are 26% of the total VOC emissions. On-road sources (27%) contribute 12% of the total VOC emissions.

Figure 48: VOC Domain Emissions - November 12, 2004

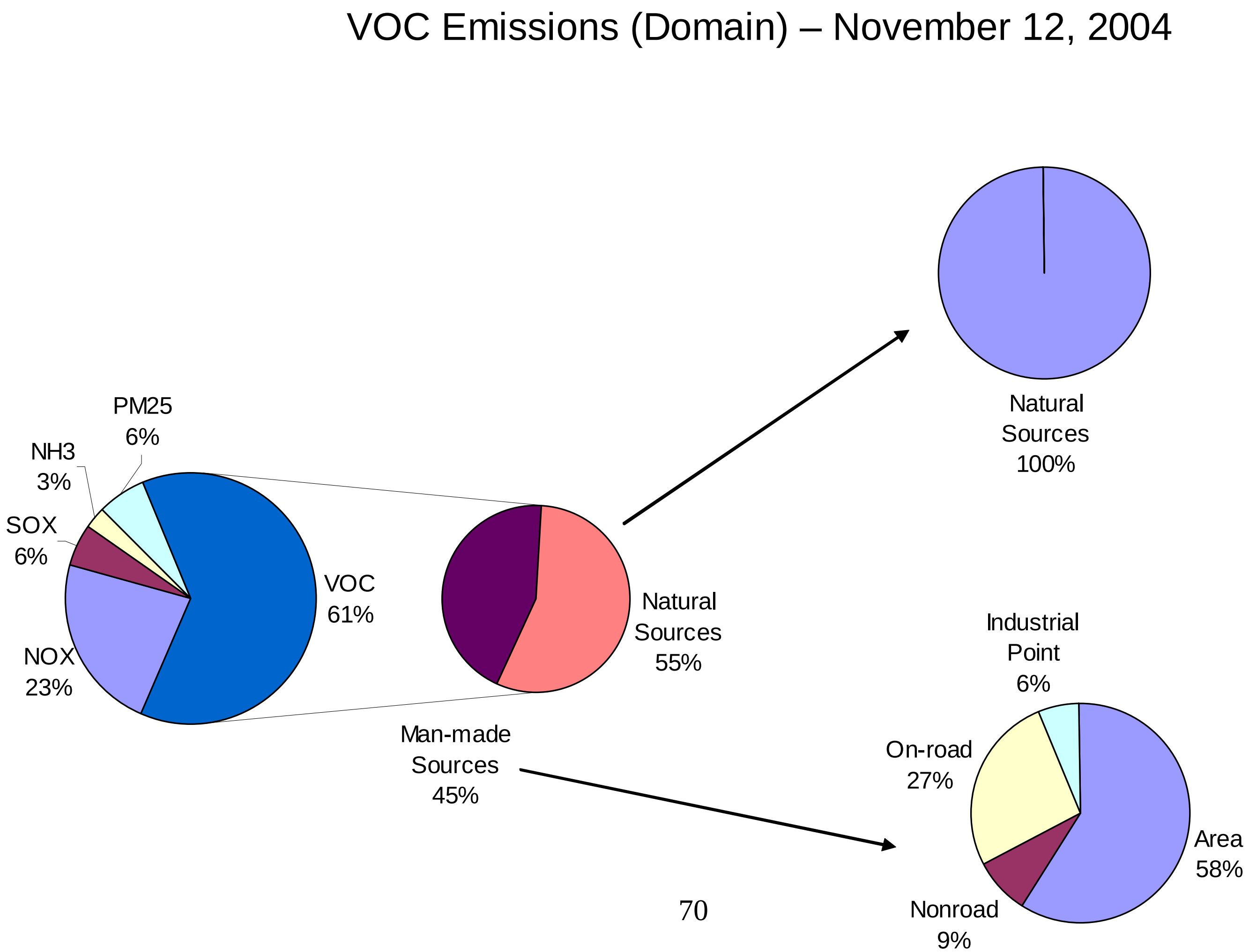
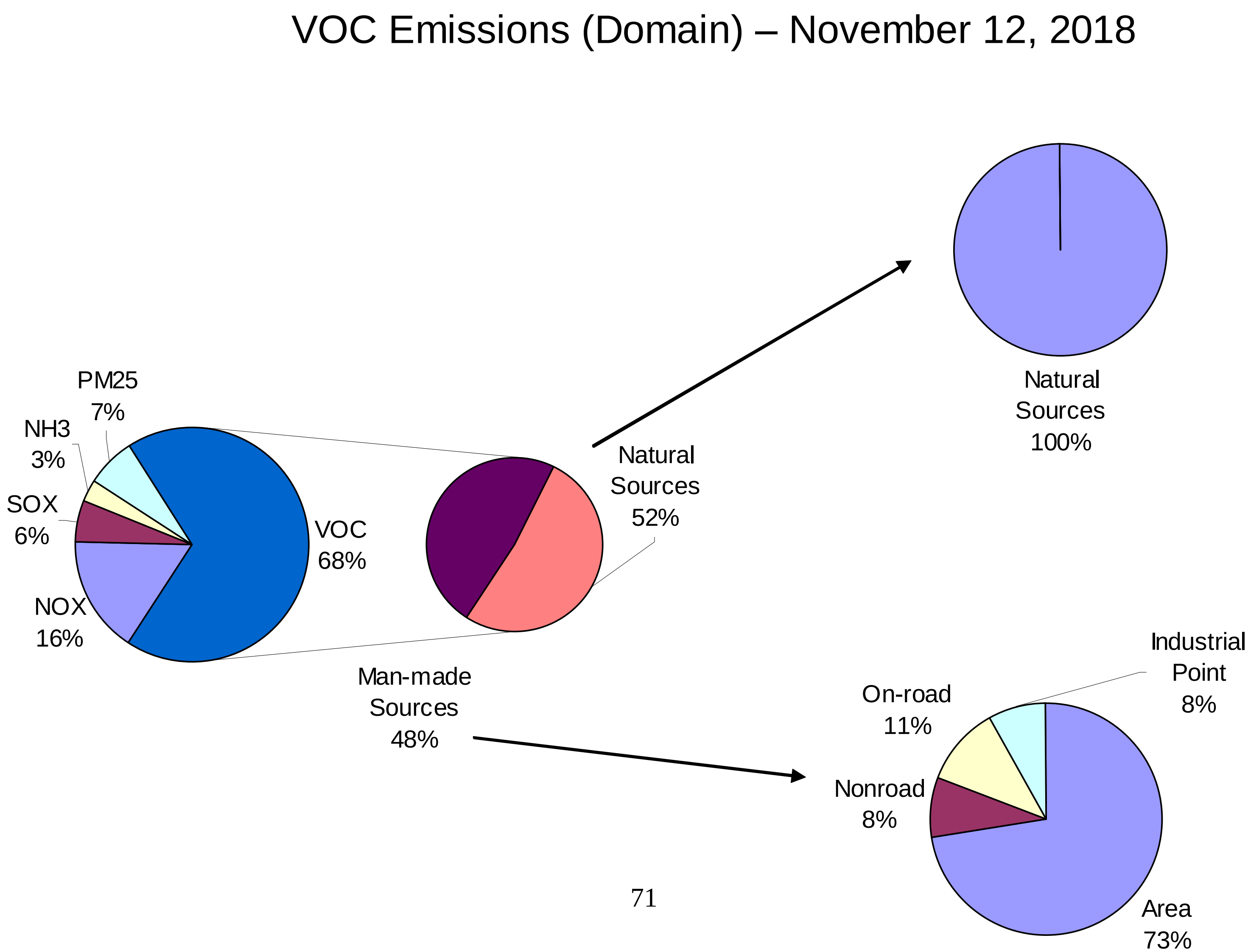


Figure 49 shows the breakdown of natural vs. man-made VOC sources for the November 12, **2018** episode. VOC emissions are 68% of the pollutant emissions for the whole domain, with natural sources comprising the majority of that contribution (52%) and man-made sources contributing 48%. "Natural sources" are the sole contributor (100%) to the natural source component of VOC. For all the man-made sources, area source emissions are 73% of the man-made source contribution and are 35% of the total VOC emissions. On-road sources (11%) contribute 5.2% of the total VOC emissions.

Figure 49: VOC Domain Emissions - November 12, 2018



D. NH3

Figures 50-53 show the distribution of NH3 emissions over the modeling domain. For the August 18, 2004, **Figure 50** shows the breakdown of natural vs. man made NH3 sources for the whole domain. NH3 is 3% of the pollutant contribution for the domain, and of that man-made sources are 69% of the NH3 contribution and natural sources comprise 31%. The charts are further distributed to show the composition of NH3 natural sources and man-made sources. Wildfires are the sole contributor (100%) to the natural source component of NH3. For all the man-made sources, area source emissions are 91% of the man-made source contribution and are 63% of the total NH3 emissions. On-road sources (8%) contribute 6% of the total NH3 emissions.

Figure 50: NH3 Domain Emissions - August 18, 2004

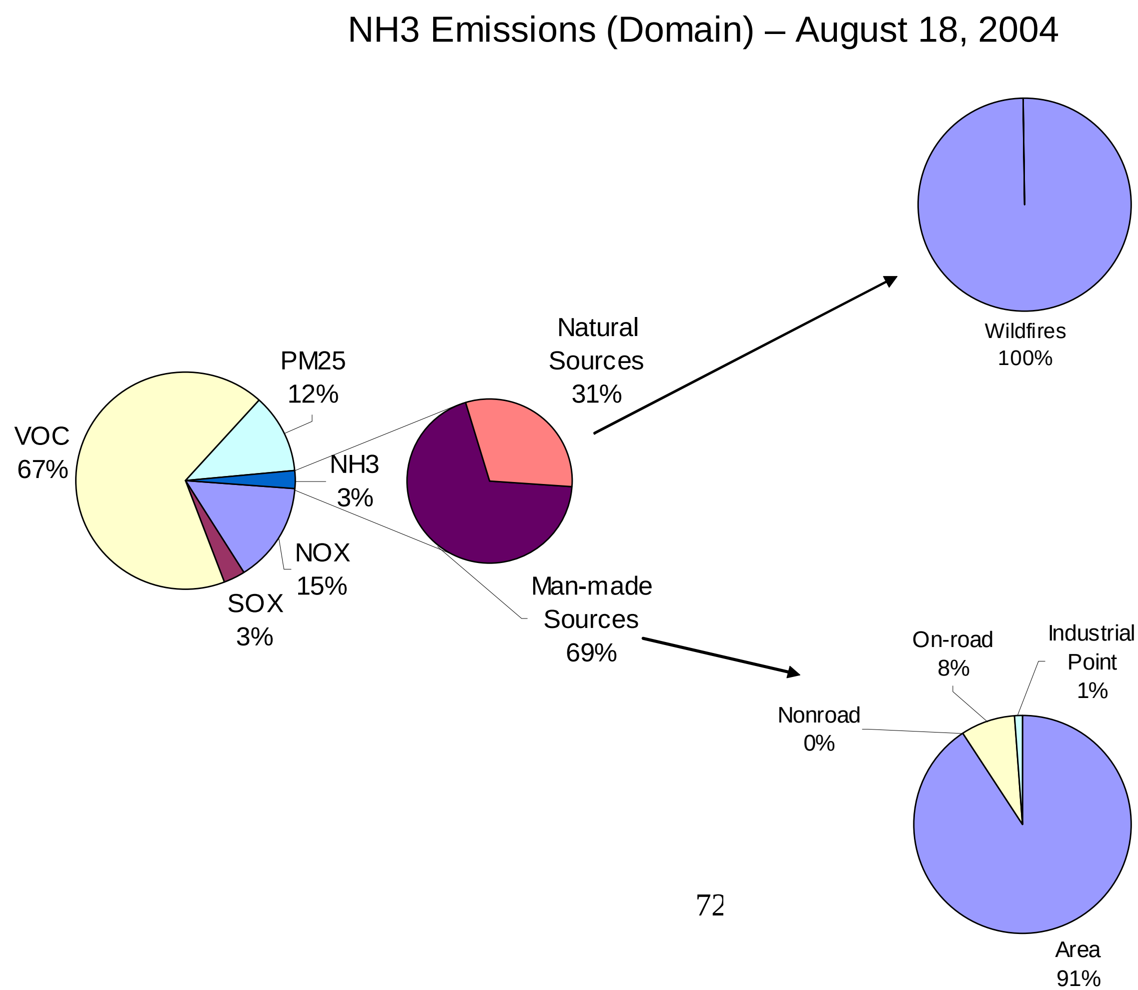
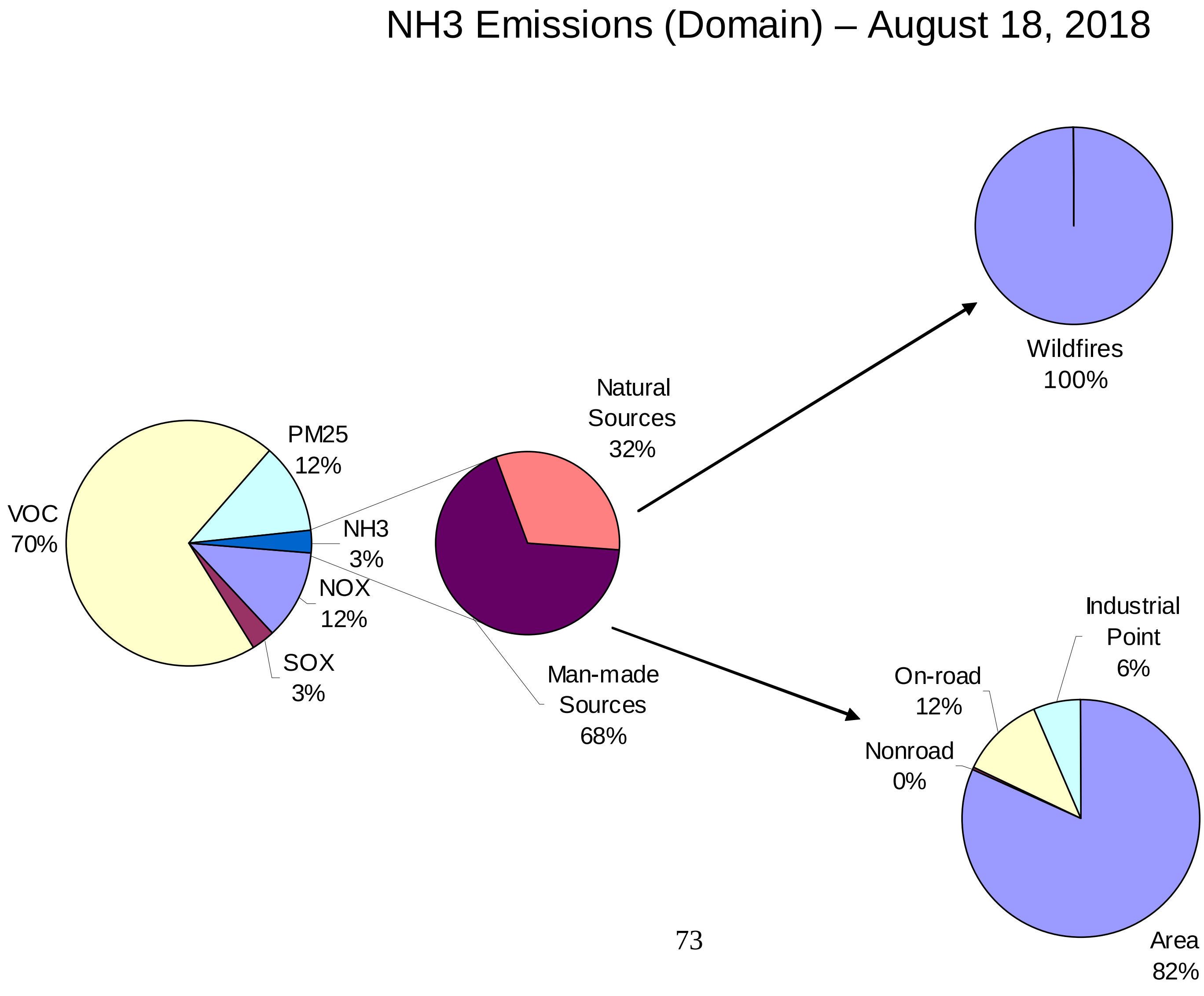


Figure 51 shows the breakdown of natural vs. man-made NH3 sources for the August 18, **2018** episode. NH3 emissions are 3% of the pollutant emissions for the whole domain, with man-made sources comprising the majority of that contribution (68%) and natural sources contributing 32%. Wildfires are the sole contributor (100%) to the natural source component of NH3. For all the man-made sources, area source emissions are 82% of the man-made source contribution and are 56% of the total NH3 emissions. On-road sources (12%) contribute 8% of the total NH3 emissions.

Figure 51: NH3 Domain Emissions - August 18, 2018



For the November 12, 2004, **Figure 52** shows the breakdown of natural vs. man made NH3 sources for the whole domain. NH3 is 3% of the pollutant contribution for the domain, and man-made sources is 100% of the NH3 contribution. The charts are further distributed to show the composition of NH3 man-made sources. For the man-made sources, area source emissions are 86% of the man-made source contribution. On-road sources contribute 12% of the total NH3 emissions.

Figure 52: NH3 Domain Emissions - November 12, 2004

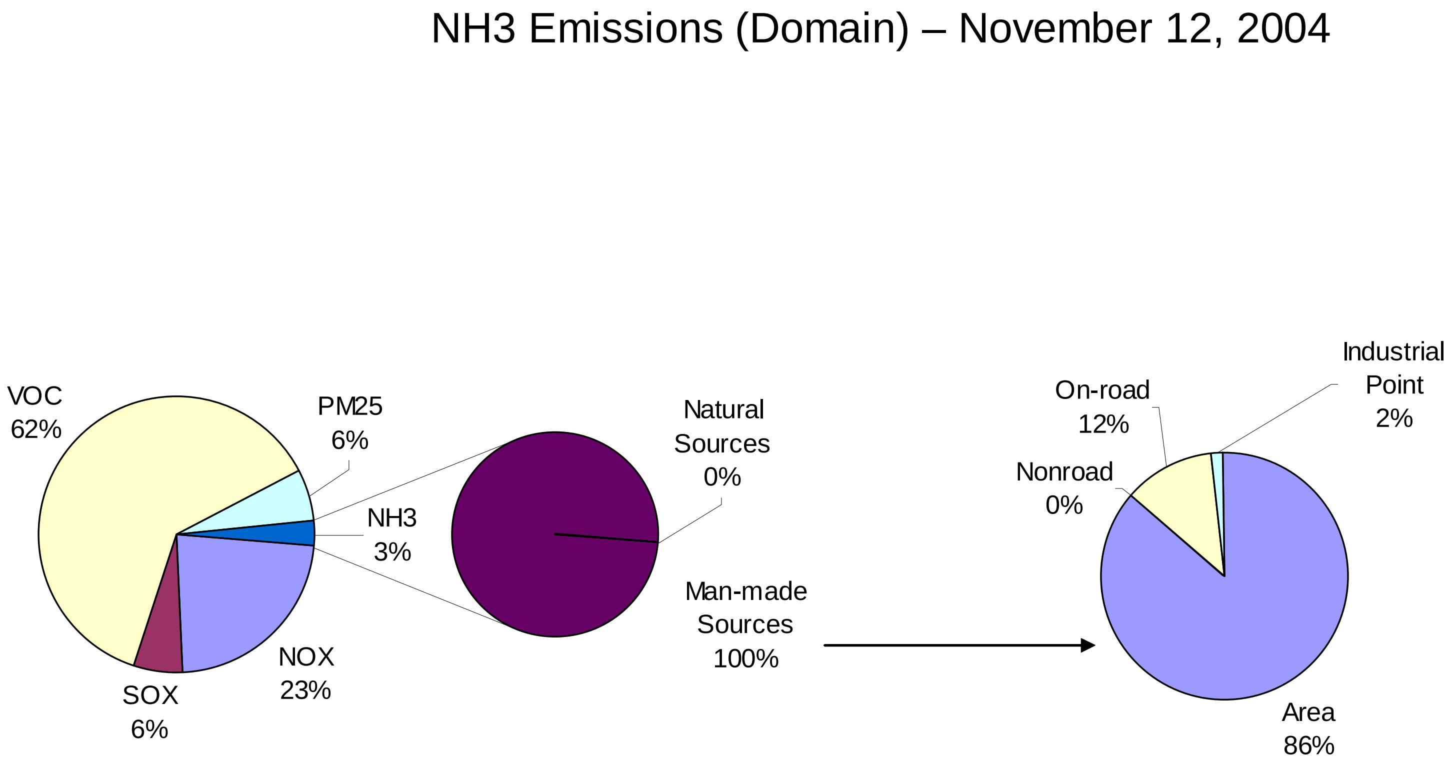
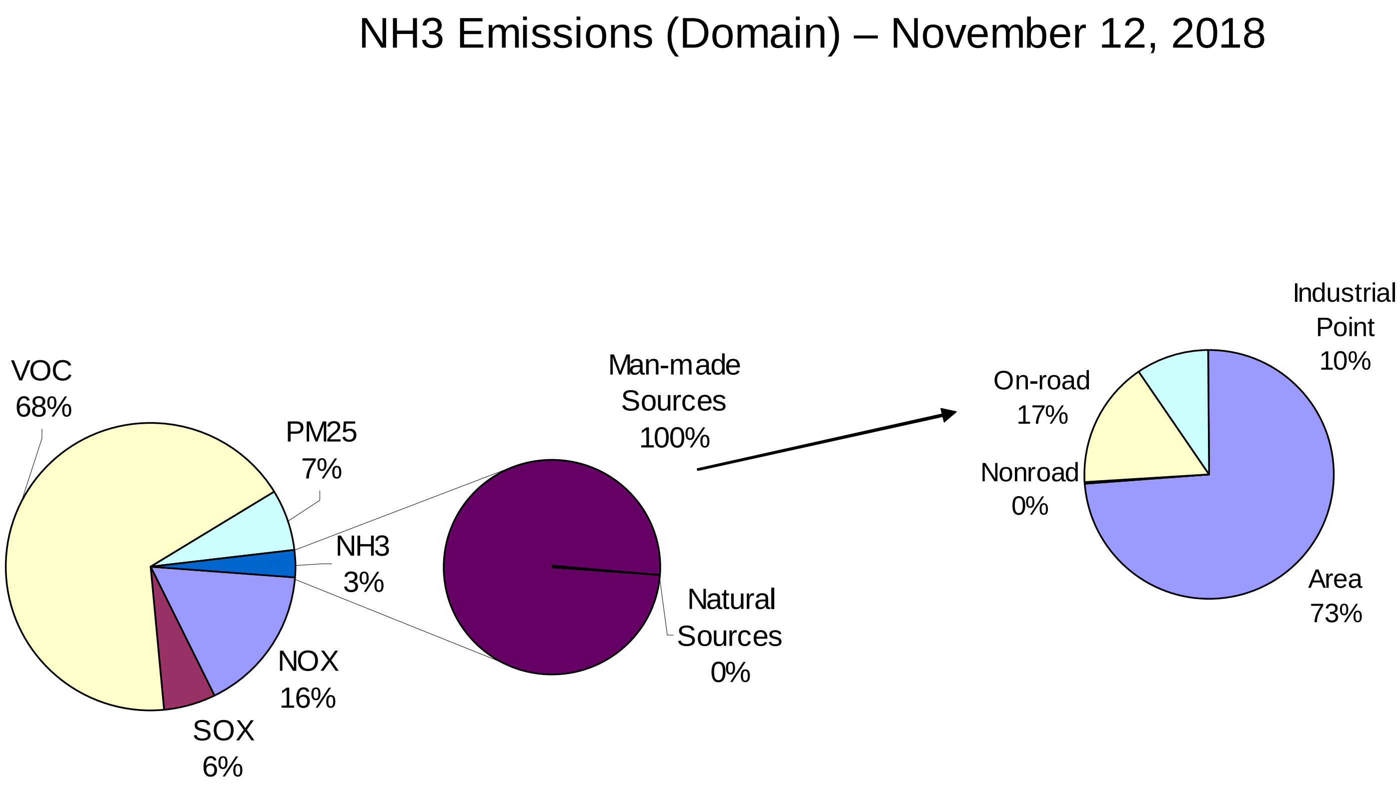


Figure 53 shows the breakdown of natural vs. man-made NH3 sources for the November 12, **2018** episode. NH3 is 3% of the pollutant contribution for the domain, and man-made sources is 100% of the NH3 contribution. The charts are further distributed to show the composition of NH3 man-made sources. For the man-made sources, area source emissions are 73% of the man-made source contribution. On-road sources contribute 17% of the total NH3 emissions and industrial point sources contribute 10%.

Figure 53: NH3 Domain Emissions - November 12, 2018



E. PM2.5

Figures 54-57 show the distribution of PM2.5 emissions over the modeling domain. For the August 18, 2004, **Figure 54** shows the breakdown of natural vs. man made PM2.5 sources for the whole domain. PM2.5 is 12% of the pollutant contribution for the domain, and of that natural sources are 88% of the PM2.5 contribution and man-made sources comprise 12%. The charts are further distributed to show the composition of PM2.5 natural sources and man-made sources. Wildfires contribute 96% to the natural source component of PM2.5 and natural sources contribute 4%. For all the man-made sources, area source emissions are 69% of the man-made source contribution and are 8% of the total PM2.5 emissions. Nonroad sources (17%) contribute 2% of the total PM2.5 emissions.

Figure 54: PM2.5 Domain Emissions - August 18, 2004

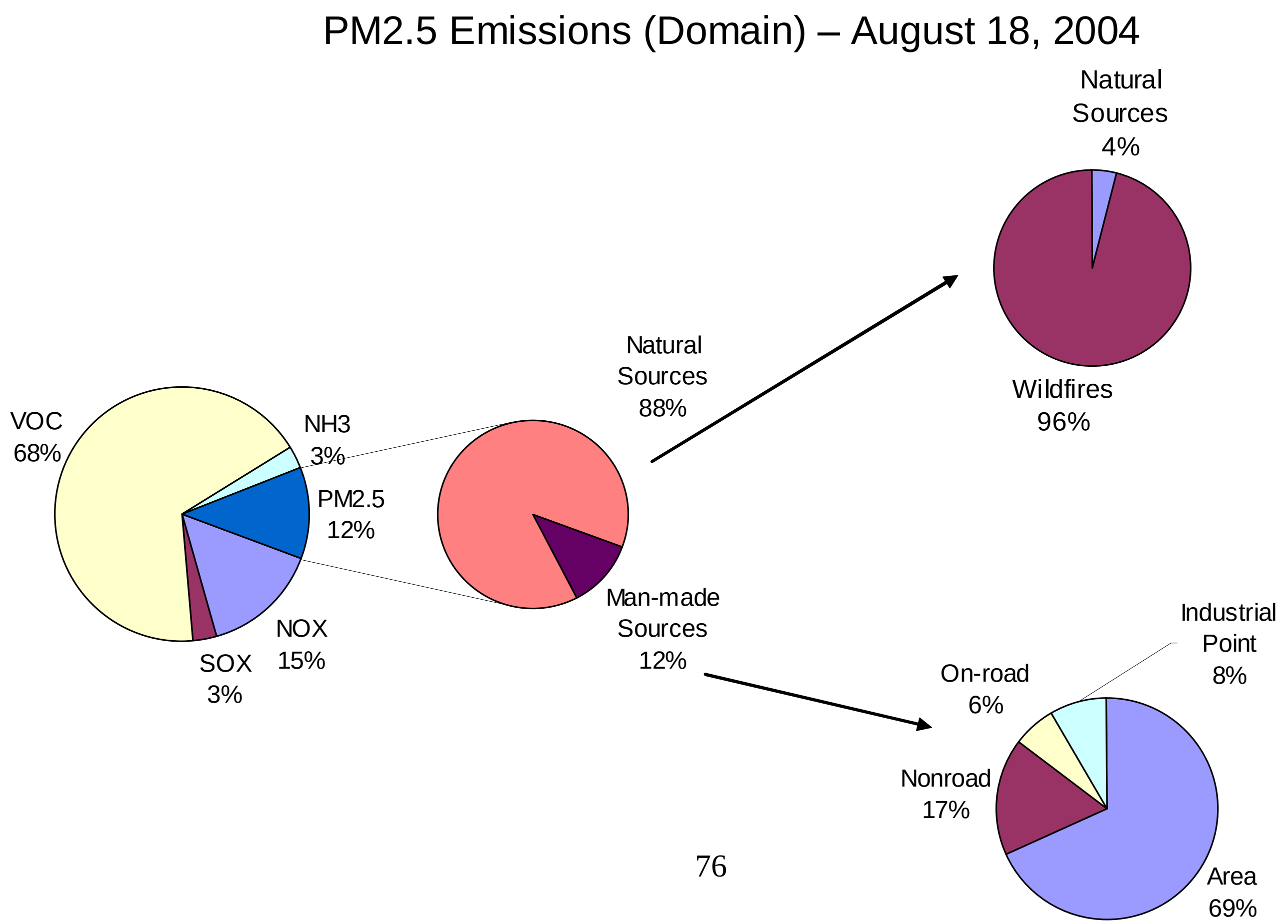
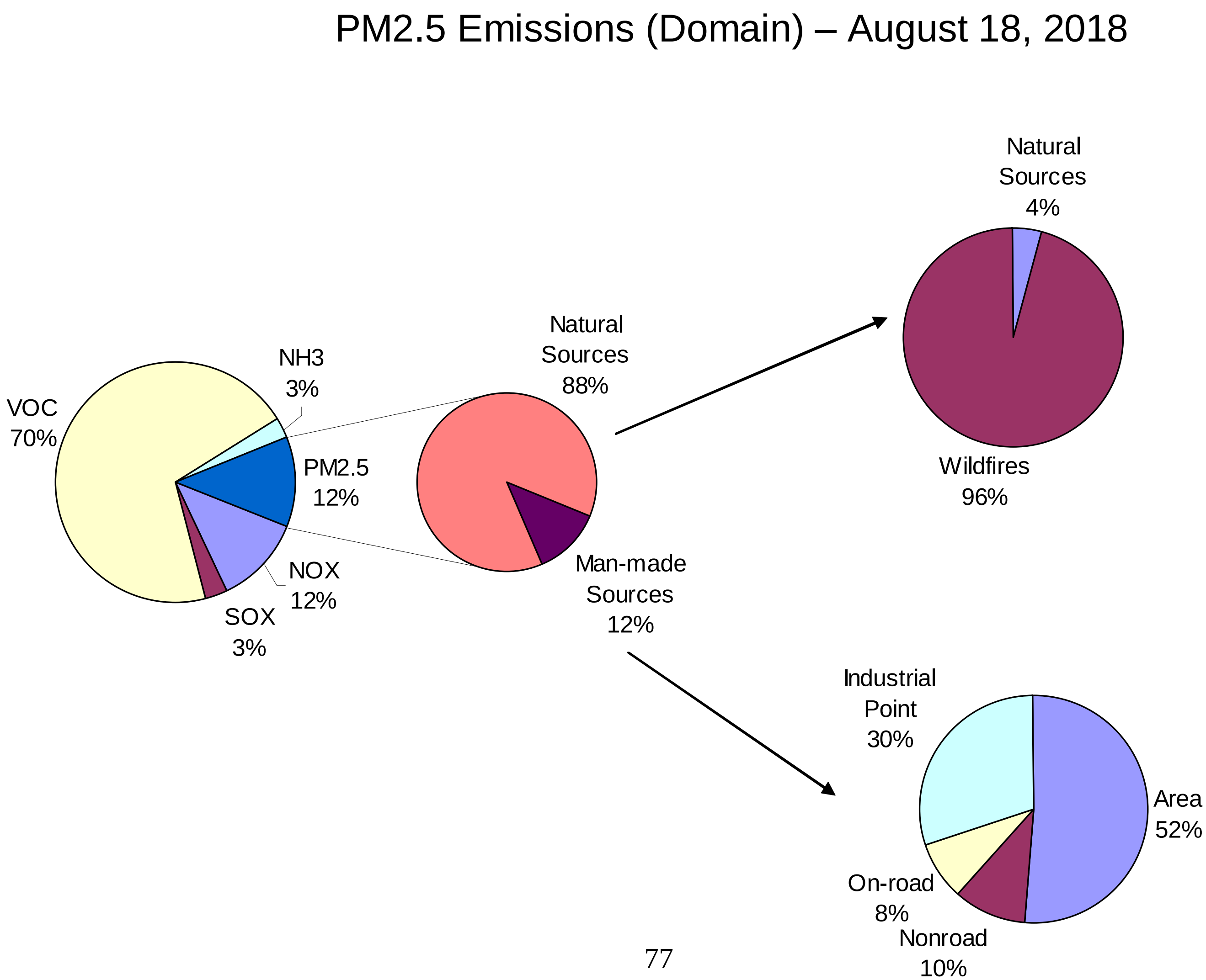


Figure 55 shows the breakdown of natural vs. man-made PM2.5 sources for the August 18, **2018** episode. PM2.5 emissions are 12% of the pollutant emissions for the whole domain, with natural sources comprising the majority of that contribution (88%) and man-made sources contributing 12%. Wildfires contribute 96% to the natural source component of PM2.5 and natural sources contribute 4%. For all the man-made sources, area source emissions are 52% of the man-made source contribution and are 6% of the total PM2.5 emissions. Industrial point sources (30%) contribute 3.6% of the total PM2.5 emissions.

Figure 55: PM2.5 Domain Emissions - August 18, 2018



For the November 12, 2004, **Figure 56** shows the breakdown of natural vs. man made PM2.5 sources for the whole domain. PM2.5 is 6% of the pollutant contribution for the domain, and of that man-made sources are 93% of the PM2.5 contribution and natural sources comprise 7%. The charts are further distributed to show the composition of PM2.5 natural sources and man-made sources. "Natural sources" are the sole contributor (100%) to the natural source component of PM2.5. For all the man-made sources, area source emissions are 88% of the man-made source contribution and are 82% of the total PM2.5 emissions. Nonroad sources (5%) contribute 5% of the total PM2.5 emissions.

Figure 56: PM2.5 Domain Emissions - November 12, 2004

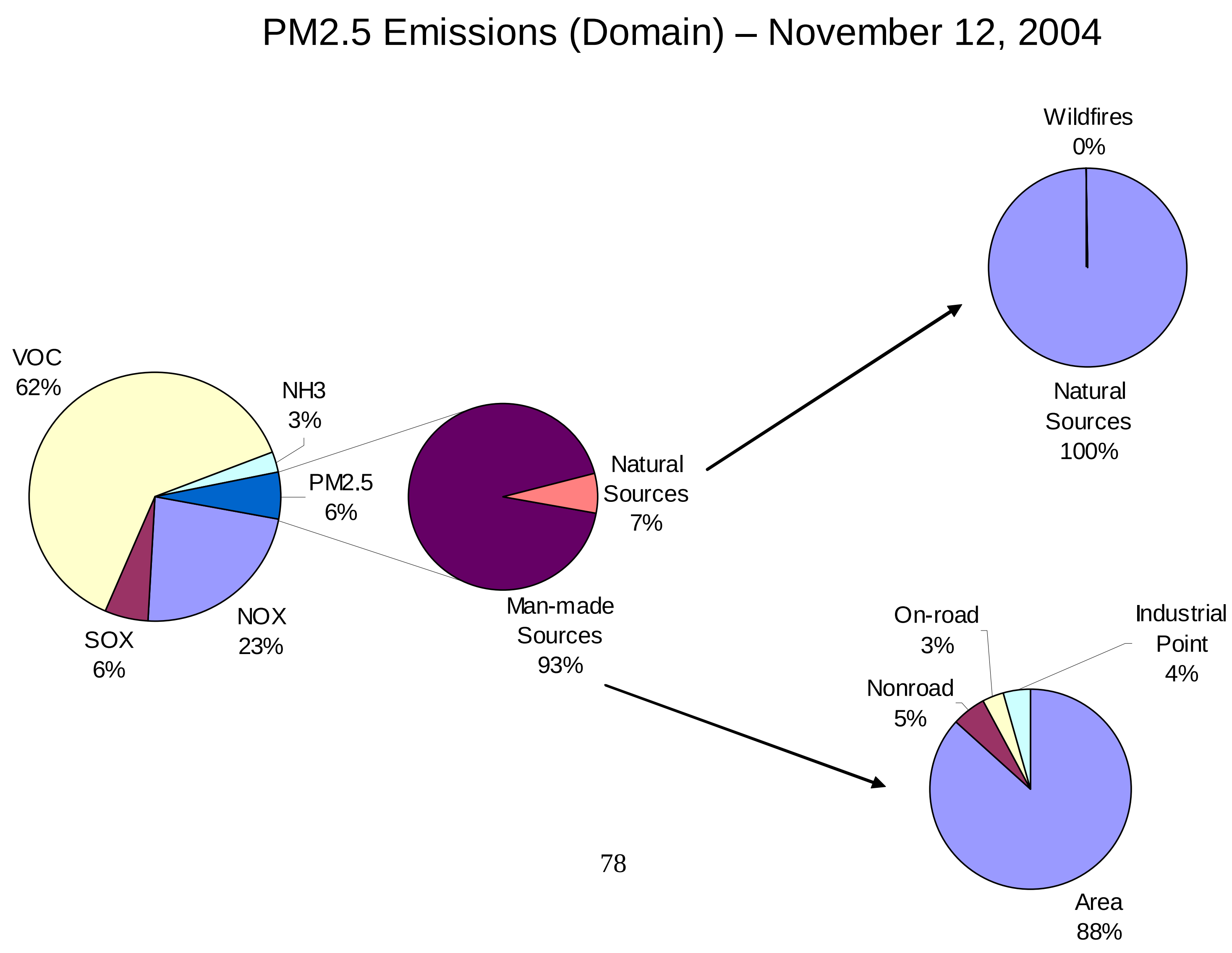
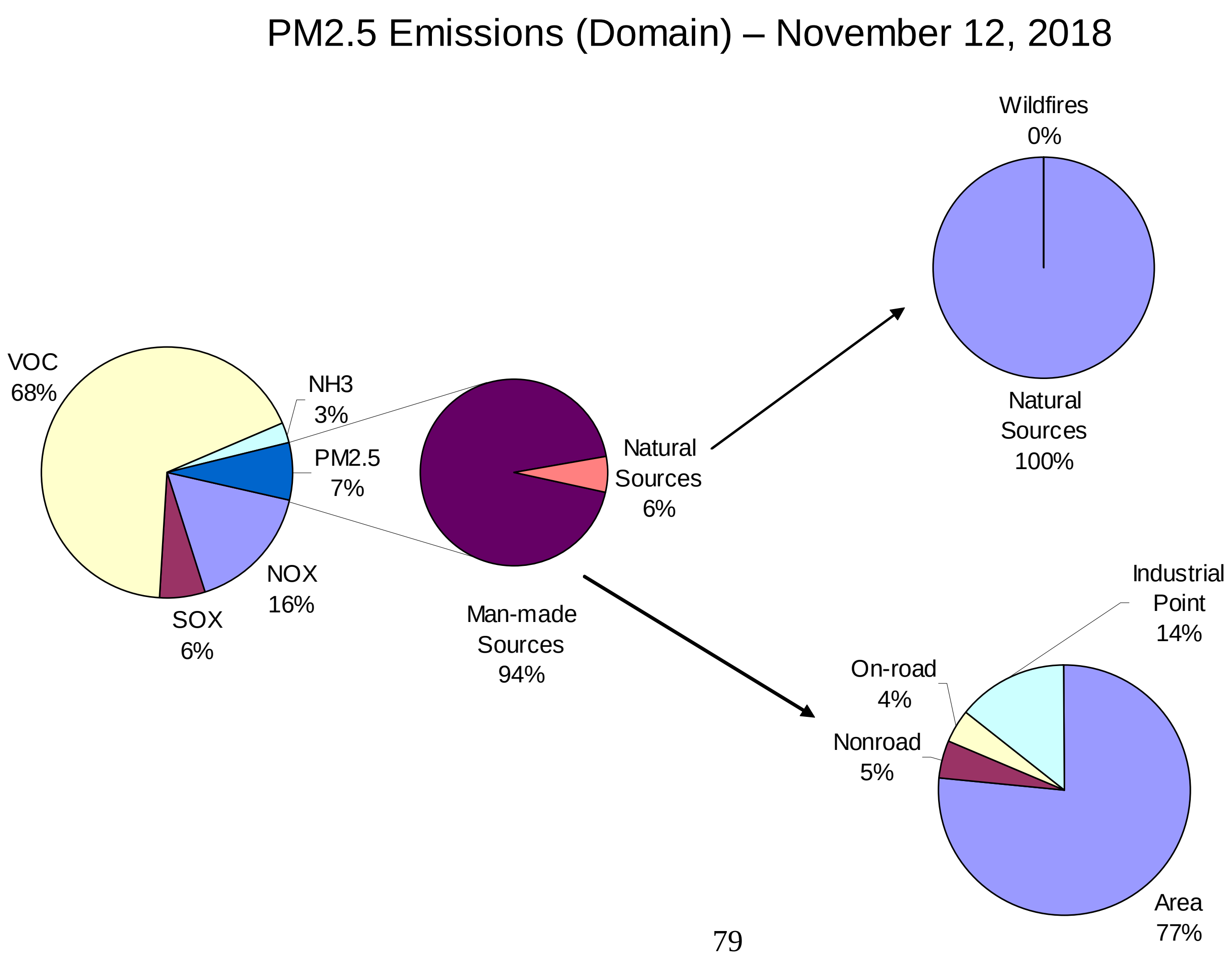


Figure 57 shows the breakdown of natural vs. man-made PM2.5 sources for the November 12, **2018** episode. PM2.5 emissions are 7% of the pollutant emissions for the whole domain, with man-made sources comprising the majority of that contribution (94%) and natural sources contributing 6%. "Natural sources" are the sole contributor (100%) to the natural source component of PM2.5. For all the man-made sources, area source emissions are 77% of the man-made source contribution and are 72% of the total PM2.5 emissions. Industrial point sources (14%) contribute 13% of the total PM2.5 emissions.

Figure 57: PM2.5 Domain Emissions - November 12, 2018



APPENDIX A

In-Gorge Anthropogenic Emissions: NH_3 + SO_X + PM_{25} + VOC + NO_X: Tons Per Day

		-- August 18th --	
Group	Category	2004	2018
Agriculture/Livestock	Fertilizer Application	0.92	0.92
Agriculture/Livestock	Livestock Operations	0.99	0.44
Agriculture/Livestock	Nonroad: Agricultural	1.21	1.43
Agriculture/Livestock	Open Burning: Agricultural	0.11	0.15
Agriculture/Livestock	Orchard Heaters	0.11	0.21
Commercial Marine (Barging-Towboats)	Nonroad: CMV	3.30	2.90
Industrial Point	Industrial Point	0.71	45.01
Nonroad Vehicles & Equipment	Nonroad: Aircraft & Aircraft Refueling	0.04	0.04
Nonroad Vehicles & Equipment	Nonroad: Airport GSE	0.00	0.00
Nonroad Vehicles & Equipment	Nonroad: Commercial	0.27	0.16
Nonroad Vehicles & Equipment	Nonroad: Construction & Mining	0.99	0.87
Nonroad Vehicles & Equipment	Nonroad: Diesel	0.01	--
Nonroad Vehicles & Equipment	Nonroad: Industrial	0.36	0.08
Nonroad Vehicles & Equipment	Nonroad: Lawn & Garden	1.62	0.92
Nonroad Vehicles & Equipment	Nonroad: Logging	0.06	0.01
Nonroad Vehicles & Equipment	Nonroad: Recreational	1.50	0.92
On-Road Mobile	On-Road Mobile	13.70	7.25
Open & Prescribed Burning	Open Burning: Land Clearing	--	0.32
Open & Prescribed Burning	Open Burning: Residential	0.46	0.75
Open & Prescribed Burning	Prescribed Burning	0.06	0.06
Other	Area: Misc. Industrial	0.25	0.36
Other	Commercial Food Preparation	0.07	0.07
Other	Degreasing	0.37	1.21
Other	Drycleaning	0.01	0.05
Other	Fuel Storage & Transport	0.62	0.82
Other	Fugitive Dust	0.43	0.00
Other	Graphic Arts	0.51	0.79
Other	Incineration	0.09	0.00
Other	Misc. Area Sources	0.33	0.41
Other	Misc. Non-Industrial Solvent Utilization	1.63	3.14
Other	Municipal (non-TV) Landfills	0.22	0.32
Other	POTWs	0.06	0.09
Other	Stationary Source Fuel Combustion	0.27	0.41
Other	TSDFs	0.00	0.00
Rail	Nonroad: Rail	12.27	8.93
Recreational Marine	Nonroad: Recreational Marine	1.46	0.40
Residential Wood Combustion	Residential Wood Combustion	0.65	0.68
Surface Coating	Surface Coating	1.57	2.43
Total		**47.2**	**82.6**

In-Gorge Anthropogenic Emissions: NH_3 + SO_X + PM_{25} + VOC + NO_X: Tons Per Day

		-- November 12th --	
Group	Category	2004	2018
Agriculture/Livestock	Fertilizer Application	0.33	0.33
Agriculture/Livestock	Livestock Operations	0.62	0.34
Agriculture/Livestock	Nonroad: Agricultural	0.15	1.43
Agriculture/Livestock	Open Burning: Agricultural	0.52	0.65
Agriculture/Livestock	Orchard Heaters	0.35	0.72
Commercial Marine (Barging-Towboats)	Nonroad: CMV	3.30	2.90
Industrial Point	Industrial Point	0.70	42.00
Nonorad Vehicles & Equipment	Nonroad: Aircraft & Aircraft Refueling	0.04	0.04
Nonorad Vehicles & Equipment	Nonroad: Airport GSE	0.00	0.00
Nonorad Vehicles & Equipment	Nonroad: Commercial	0.27	0.16
Nonorad Vehicles & Equipment	Nonroad: Construction & Mining	0.68	0.87
Nonorad Vehicles & Equipment	Nonroad: Diesel	0.01	--
Nonorad Vehicles & Equipment	Nonroad: Industrial	0.25	0.08
Nonorad Vehicles & Equipment	Nonroad: Lawn & Garden	0.33	0.92
Nonorad Vehicles & Equipment	Nonroad: Logging	0.06	0.01
Nonorad Vehicles & Equipment	Nonroad: Recreational	1.92	0.92
On-Road Mobile	On-Road Mobile	15.57	7.88
Other	Area: Misc. Industrial	0.25	0.36
Other	Commercial Food Preparation	0.07	0.07
Other	Degreasing	0.38	1.23
Other	Drycleaning	0.01	0.05
Other	Fuel Storage & Transport	0.62	0.82
Other	Fugitive Dust	0.33	0.00
Other	Graphic Arts	0.51	0.79
Other	Incineration	0.09	0.00
Other	Misc. Area Sources	0.33	0.41
Other	Misc. Non-Industrial Solvent Utilization	1.65	3.18
Other	Municipal (non-TV) Landfills	0.22	0.32
Other	Open Burning: Land Clearing	--	0.36
Other	Open Burning: Residential	0.47	0.76
Other	POTWs	0.06	0.09
Other	Stationary Source Fuel Combustion	0.56	0.73
Other	TSDFs	0.00	0.00
Prescribed Burning	Prescribed Burning	15.91	15.91
Rail	Nonroad: Rail	12.27	8.93
Recreational Marine	Nonroad: Recreational Marine	1.16	0.40
Residential Wood Combustion	Residential Wood Combustion	6.63	6.89
Surface Coating	Surface Coating	1.56	2.43
		68.2	**103.0**

Portland Anthropogenic Emissions: NH_3 + SO_X + PM_{25} + VOC + NO_X: Tons Per Day

		-- August 18th --	
Group	Category	2004	2018
Agriculture/Livestock	Fertilizer Application	1.76	1.76
Agriculture/Livestock	Livestock Operations	13.58	11.67
Agriculture/Livestock	Nonroad: Agricultural	3.28	3.97
Agriculture/Livestock	Open Burning: Agricultural	0.04	0.04
Agriculture/Livestock	Orchard Heaters	0.17	0.19
Commercial Marine Vessels	Nonroad: CMV	4.64	4.49
Degreasing	Degreasing	13.26	54.21
Graphic Arts	Graphic Arts	8.21	35.02
Industrial Point	Industrial Point	20.57	33.22
Misc. Area Sources	Area: Misc. Industrial	12.83	15.49
Misc. Area Sources	Misc. Area Sources	3.87	4.46
Misc. Area Sources	Misc. Non-Industrial Solvent Utilization	20.22	27.70
Nonroad Vehicles & Equipment	Nonroad: Aircraft & Aircraft Refueling	3.21	3.68
Nonroad Vehicles & Equipment	Nonroad: Airport GSE	0.00	0.11
Nonroad Vehicles & Equipment	Nonroad: Commercial	11.45	6.57
Nonroad Vehicles & Equipment	Nonroad: Construction & Mining	35.13	17.92
Nonroad Vehicles & Equipment	Nonroad: Diesel	0.87	--
Nonroad Vehicles & Equipment	Nonroad: Industrial	13.71	2.60
Nonroad Vehicles & Equipment	Nonroad: Logging	0.30	0.34
Nonroad Vehicles & Equipment	Nonroad: Recreational	5.24	3.08
Nonroad: Lawn & Garden	Nonroad: Lawn & Garden	47.54	25.38
On-Road Mobile	On-Road Mobile	171.64	74.97
Other	Commercial Food Preparation	0.41	11.51
Other	Drycleaning	0.21	4.75
Other	Fuel Storage & Transport	3.08	4.66
Other	Fugitive Dust	2.62	0.00
Other	Incineration	1.34	0.48
Other	Municipal (non-TV) Landfills	0.37	0.53
Other	Open Burning: Land Clearing	--	4.96
Other	Open Burning: Residential	1.83	3.76
Other	POTWs	0.89	1.32
Other	Prescribed Burning	0.33	0.33
Other	Residential Wood Combustion	7.21	7.50
Other	TSDFs	0.30	0.43
Rail	Nonroad: Rail	9.02	6.02
Recreational Marine	Nonroad: Recreational Marine	7.27	2.14
Stationary Source Fuel Combustion	Stationary Source Fuel Combustion	13.18	16.33
Surface Coating	Surface Coating	59.81	102.69
Total		**499.4**	**494.3**

Portland Anthropogenic Emissions: NH_3 + SO_X + PM_{25} + VOC + NO_X: Tons Per Day

		-- November 12th --	
Group	Category	2004	2018
Agriculture/Livestock	Fertilizer Application	0.69	0.69
Agriculture/Livestock	Livestock Operations	9.71	8.75
Agriculture/Livestock	Nonroad: Agricultural	0.40	3.97
Agriculture/Livestock	Open Burning: Agricultural	0.56	0.58
Agriculture/Livestock	Orchard Heaters	0.58	0.65
Commercial Marine Vessels	Nonroad: CMV	4.64	4.49
Graphic Arts	Graphic Arts	8.21	35.02
Industrial Point	Industrial Point	22.31	32.84
Misc. Area Sources	Area: Misc. Industrial	12.82	15.49
Misc. Area Sources	Degreasing	13.42	54.85
Misc. Area Sources	Misc. Area Sources	3.87	4.46
Misc. Area Sources	Misc. Non-Industrial Solvent Utilization	20.43	27.95
Nonroad Vehicles & Equipment	Nonroad: Aircraft & Aircraft Refueling	3.21	3.68
Nonroad Vehicles & Equipment	Nonroad: Airport GSE	0.00	0.11
Nonroad Vehicles & Equipment	Nonroad: Commercial	11.50	6.57
Nonroad Vehicles & Equipment	Nonroad: Diesel	0.87	--
Nonroad Vehicles & Equipment	Nonroad: Industrial	9.42	2.60
Nonroad Vehicles & Equipment	Nonroad: Lawn & Garden	11.46	25.38
Nonroad Vehicles & Equipment	Nonroad: Logging	0.31	0.34
Nonroad Vehicles & Equipment	Nonroad: Recreational	1.55	3.08
Nonroad: Construction & Mining	Nonroad: Construction & Mining	23.64	17.92
On-Road Mobile	On-Road Mobile	195.18	83.92
Other	Commercial Food Preparation	0.41	11.51
Other	Drycleaning	0.21	4.75
Other	Fuel Storage & Transport	3.08	4.66
Other	Fugitive Dust	2.46	0.00
Other	Incineration	1.34	0.48
Other	Municipal (non-TV) Landfills	0.37	0.53
Other	Open Burning: Land Clearing	--	5.65
Other	Open Burning: Residential	1.89	3.84
Other	POTWs	0.89	1.32
Other	Prescribed Burning	1.13	1.13
Other	TSDFs	0.30	0.43
Rail	Nonroad: Rail	9.02	6.02
Recreational Marine	Nonroad: Recreational Marine	6.90	2.14
Residential Wood Combustion	Residential Wood Combustion	73.99	76.95
Stationary Source Fuel Combustion	Stationary Source Fuel Combustion	21.58	26.15
Surface Coating	Surface Coating	59.73	102.78
		538.1	**581.7**

Northwest of Gorge Anthropogenic Emissions: NH_3 + SO_X + PM_{25} + VOC + NO_X: Ton

		-- August 18th --	
Group	Category	2004	2018
Agriculture/Livestock	Fertilizer Application	0.87	0.87
Agriculture/Livestock	Livestock Operations	3.03	1.34
Agriculture/Livestock	Nonroad: Agricultural	0.64	0.66
Agriculture/Livestock	Open Burning: Agricultural	0.00	0.00
Agriculture/Livestock	Orchard Heaters	0.00	0.00
Commercial Marine Vessels	Nonroad: CMV	18.87	19.66
Industrial Point	Industrial Point	127.91	70.71
Misc. Area Sources	Area: Misc. Industrial	2.12	2.92
Misc. Area Sources	Misc. Area Sources	0.83	0.74
Misc. Area Sources	Misc. Non-Industrial Solvent Utilization	2.00	3.21
Nonroad Vehicles & Equipment	Nonroad: Aircraft & Aircraft Refueling	0.13	0.16
Nonroad Vehicles & Equipment	Nonroad: Airport GSE	0.00	0.00
Nonroad Vehicles & Equipment	Nonroad: Commercial	0.48	0.33
Nonroad Vehicles & Equipment	Nonroad: Construction & Mining	2.15	1.44
Nonroad Vehicles & Equipment	Nonroad: Diesel	0.00	--
Nonroad Vehicles & Equipment	Nonroad: Industrial	1.70	0.30
Nonroad Vehicles & Equipment	Nonroad: Lawn & Garden	2.03	1.42
Nonroad Vehicles & Equipment	Nonroad: Logging	1.69	1.53
Nonroad Vehicles & Equipment	Nonroad: Recreational	3.65	1.90
On-Road Mobile	On-Road Mobile	31.44	15.85
Other	Commercial Food Preparation	0.17	0.28
Other	Degreasing	0.74	1.93
Other	Drycleaning	0.04	0.10
Other	Fuel Storage & Transport	2.08	4.55
Other	Fugitive Dust	0.32	0.00
Other	Graphic Arts	0.35	0.71
Other	Incineration	0.46	0.01
Other	Municipal (non-TV) Landfills	0.00	0.00
Other	Open Burning: Land Clearing	--	1.37
Other	Open Burning: Residential	0.94	1.71
Other	POTWs	0.24	0.35
Other	Prescribed Burning	0.55	0.55
Other	Residential Wood Combustion	1.80	1.87
Other	Stationary Source Fuel Combustion	1.06	1.34
Other	TSDFs	0.00	0.00
Rail	Nonroad: Rail	2.63	2.86
Recreational Marine	Nonroad: Recreational Marine	4.04	3.01
Surface Coating	Surface Coating	4.59	6.31
Total		**219.6**	**150.0**

Northwest of Gorge Anthropogenic Emissions: NH_3 + SO_X + PM_{25} + VOC + NO_X: Ton

Group	Category	-- November 12th -- 2004	2018
Commercial Marine Vessels	Nonroad: CMV	18.87	19.66
Fuel Storage, Transport, & Dispensing	Fuel Storage & Transport	2.08	4.55
Industrial Point	Industrial Point	121.84	69.74
Misc. Area Sources	Area: Misc. Industrial	2.12	2.92
Misc. Area Sources	Misc. Area Sources	0.83	0.74
Misc. Area Sources	Misc. Non-Industrial Solvent Utilization	2.02	3.23
Nonroad Vehicles & Equipment	Nonroad: Aircraft & Aircraft Refueling	0.13	0.16
Nonroad Vehicles & Equipment	Nonroad: Airport GSE	0.00	0.00
Nonroad Vehicles & Equipment	Nonroad: Commercial	0.49	0.33
Nonroad Vehicles & Equipment	Nonroad: Construction & Mining	1.47	1.44
Nonroad Vehicles & Equipment	Nonroad: Diesel	0.00	--
Nonroad Vehicles & Equipment	Nonroad: Industrial	1.17	0.30
Nonroad Vehicles & Equipment	Nonroad: Lawn & Garden	0.38	1.42
Nonroad Vehicles & Equipment	Nonroad: Logging	1.73	1.53
Nonroad Vehicles & Equipment	Nonroad: Recreational	1.04	1.90
On-Road Mobile	On-Road Mobile	34.15	17.10
Open Burning: Land Clearing	Open Burning: Land Clearing	--	1.57
Open Burning: Residential	Open Burning: Residential	0.96	1.73
Other	Commercial Food Preparation	0.17	0.28
Other	Degreasing	0.75	1.95
Other	Drycleaning	0.04	0.10
Other	Fertilizer Application	0.15	0.15
Other	Fugitive Dust	0.28	0.00
Other	Graphic Arts	0.35	0.71
Other	Incineration	0.46	0.01
Other	Livestock Operations	2.05	1.20
Other	Municipal (non-TV) Landfills	0.00	0.00
Other	Nonroad: Agricultural	0.08	0.66
Other	Open Burning: Agricultural	0.00	0.00
Other	Orchard Heaters	0.00	0.00
Other	POTWs	0.24	0.35
Other	Stationary Source Fuel Combustion	1.63	1.97
Other	TSDFs	0.00	0.00
Prescribed Burning	Prescribed Burning	7.24	7.24
Rail	Nonroad: Rail	2.63	2.86
Recreational Marine	Nonroad: Recreational Marine	3.04	3.01
Residential Wood Combustion	Residential Wood Combustion	17.85	18.56
Surface Coating	Surface Coating	4.61	6.30
		230.9	**173.7**

West of Gorge Anthropogenic Emissions: NH_3 + SO_X + PM_{25} + VOC + NO_X: Tons Per

Group	Category	-- August 18th -- 2004	2018
Agriculture	Fertilizer Application	7.88	7.88
Agriculture	Nonroad: Agricultural	16.15	18.77
Agriculture	Open Burning: Agricultural	0.13	0.15
Agriculture	Orchard Heaters	0.46	0.47
Commercial Marine Vessels	Nonroad: CMV	0.41	48.80
Fuel Storage, Transport, & Dispensing	Fuel Storage & Transport	27.09	78.44
Industrial Point	Industrial Point	129.76	267.78
Livestock Operations	Livestock Operations	49.30	35.86
Misc. Area Sources	Area: Misc. Industrial	23.07	35.17
Misc. Area Sources	Degreasing	16.67	63.03
Misc. Area Sources	Graphic Arts	14.37	32.53
Misc. Area Sources	Misc. Area Sources	16.23	13.00
Misc. Area Sources	Misc. Non-Industrial Solvent Utilization	52.60	46.67
Nonroad Vehicles & Equipment	Nonroad: Aircraft & Aircraft Refueling	0.72	7.98
Nonroad Vehicles & Equipment	Nonroad: Airport GSE	0.68	0.34
Nonroad Vehicles & Equipment	Nonroad: Commercial	22.48	14.25
Nonroad Vehicles & Equipment	Nonroad: Construction & Mining	86.03	38.72
Nonroad Vehicles & Equipment	Nonroad: Diesel	0.02	--
Nonroad Vehicles & Equipment	Nonroad: Industrial	38.43	6.61
Nonroad Vehicles & Equipment	Nonroad: Logging	6.79	6.47
Nonroad Vehicles & Equipment	Nonroad: Recreational	18.68	12.99
Nonroad: Lawn & Garden	Nonroad: Lawn & Garden	88.60	51.21
On-Road Mobile	On-Road Mobile	708.94	282.64
Other	Commercial Food Preparation	7.77	10.49
Other	Drycleaning	7.61	11.31
Other	Fugitive Dust	5.27	0.00
Other	Incineration	11.20	0.20
Other	Municipal (non-TV) Landfills	1.32	1.86
Other	Open Burning: Land Clearing	0.09	28.50
Other	Open Burning: Residential	7.79	38.14
Other	Placeholder	0.22	--
Other	POTWs	7.54	11.20
Other	Prescribed Burning	4.35	4.78
Other	Residential Wood Combustion	37.30	38.79
Other	TSDFs	0.14	0.21
Rail	Nonroad: Rail	28.19	18.51
Recreational Marine	Nonroad: Recreational Marine	21.58	27.71
Stationary Source Fuel Combustion	Stationary Source Fuel Combustion	21.03	43.94
Surface Coating	Surface Coating	89.78	146.69
Total		**1,576.7**	**1,452.1**

West of Gorge Anthropogenic Emissions: NH_3 + SO_X + PM_{25} + VOC + NO_X: Tons Per

Group	Category	-- November 12th -- 2004	2018
Agriculture	Fertilizer Application	1.95	1.95
Agriculture	Nonroad: Agricultural	2.52	18.77
Agriculture	Open Burning: Agricultural	12.13	12.17
Agriculture	Orchard Heaters	1.55	1.57
Commercial Marine Vessels	Nonroad: CMV	0.41	48.80
Degreasing	Degreasing	16.87	63.78
Fuel Storage, Transport, & Dispensing	Fuel Storage & Transport	27.09	78.44
Graphic Arts	Graphic Arts	14.37	32.53
Industrial Point	Industrial Point	127.37	259.81
Livestock Operations	Livestock Operations	38.65	31.88
Misc. Area Sources	Area: Misc. Industrial	23.07	35.17
Misc. Area Sources	Misc. Area Sources	16.23	13.00
Misc. Area Sources	Misc. Non-Industrial Solvent Utilization	53.15	47.04
Nonroad Vehicles & Equipment	Nonroad: Aircraft & Aircraft Refueling	0.71	7.98
Nonroad Vehicles & Equipment	Nonroad: Airport GSE	0.69	0.34
Nonroad Vehicles & Equipment	Nonroad: Commercial	23.53	14.25
Nonroad Vehicles & Equipment	Nonroad: Construction & Mining	58.96	38.72
Nonroad Vehicles & Equipment	Nonroad: Diesel	0.02	--
Nonroad Vehicles & Equipment	Nonroad: Industrial	26.57	6.61
Nonroad Vehicles & Equipment	Nonroad: Logging	6.93	6.47
Nonroad Vehicles & Equipment	Nonroad: Recreational	9.82	12.99
Nonroad: Lawn & Garden	Nonroad: Lawn & Garden	30.64	51.21
On-Road Mobile	On-Road Mobile	746.65	298.57
Open Burning: Residential & Land Clearing	Open Burning: Land Clearing	0.10	32.48
Open Burning: Residential & Land Clearing	Open Burning: Residential	8.13	38.35
Other	Commercial Food Preparation	7.77	10.49
Other	Drycleaning	7.61	11.31
Other	Fugitive Dust	4.85	0.00
Other	Incineration	11.20	0.20
Other	Municipal (non-TV) Landfills	1.32	1.86
Other	Placeholder	0.22	--
Other	POTWs	7.54	11.20
Other	TSDFs	0.14	0.21
Prescribed Burning	Prescribed Burning	71.01	72.49
Rail	Nonroad: Rail	28.19	18.51
Recreational Marine	Nonroad: Recreational Marine	10.57	27.71
Residential Wood Combustion	Residential Wood Combustion	366.00	380.64
Stationary Source Fuel Combustion	Stationary Source Fuel Combustion	47.98	70.60
Surface Coating	Surface Coating	89.84	146.72
		1,902.3	**1,904.8**

East of Gorge Anthropogenic Emissions: NH_3 + SO_X + PM_{25} + VOC + NO_X: Tons Per Day

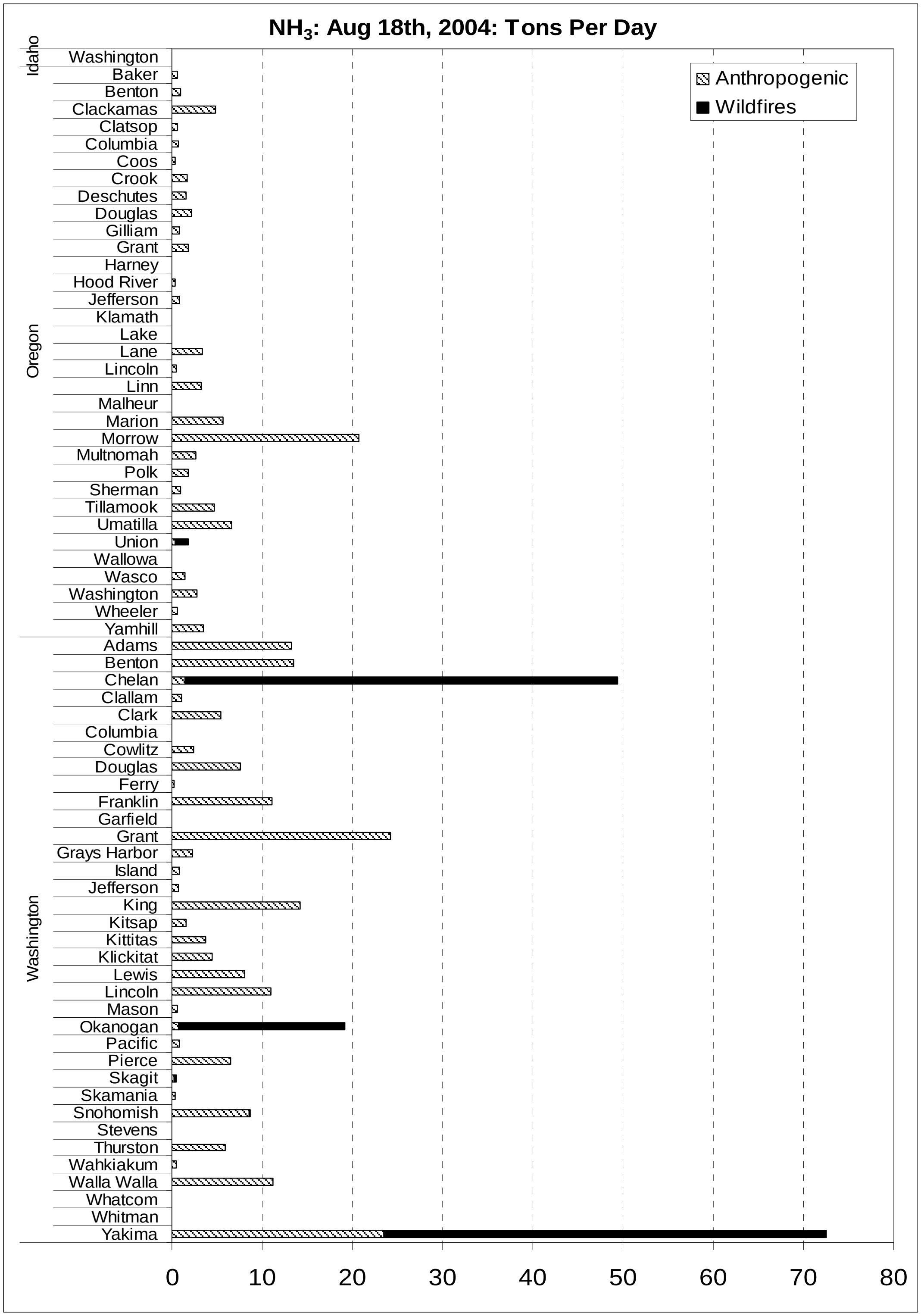
Group	Category	-- August 18th -- 2004	2018
Agriculture	Fertilizer Application	79.52	79.52
Agriculture	Nonroad: Agricultural	79.49	71.15
Agriculture	Open Burning: Agricultural	62.36	62.35
Agriculture	Orchard Heaters	0.20	0.10
Degreasing	Degreasing	3.86	18.74
Fuel Storage, Transport, & Dispensing	Fuel Storage & Transport	14.46	23.90
Fugitive Dust	Fugitive Dust	54.12	0.00
Industrial Point	Industrial Point	112.44	121.04
Livestock Operations	Livestock Operations	82.85	47.60
Misc. Area Sources	Area: Misc. Industrial	10.10	14.59
Misc. Area Sources	Graphic Arts	2.60	3.44
Misc. Area Sources	Misc. Area Sources	7.92	7.37
Misc. Area Sources	Misc. Non-Industrial Solvent Utilization	21.83	54.26
Nonroad Vehicles & Equip (includes marine)	Nonroad: Aircraft & Aircraft Refueling	0.75	0.82
Nonroad Vehicles & Equip (includes marine)	Nonroad: Airport GSE	0.02	0.01
Nonroad Vehicles & Equip (includes marine)	Nonroad: CMV	4.93	4.85
Nonroad Vehicles & Equip (includes marine)	Nonroad: Commercial	3.82	2.63
Nonroad Vehicles & Equip (includes marine)	Nonroad: Construction & Mining	18.91	10.37
Nonroad Vehicles & Equip (includes marine)	Nonroad: Diesel	0.00	--
Nonroad Vehicles & Equip (includes marine)	Nonroad: Industrial	5.67	1.08
Nonroad Vehicles & Equip (includes marine)	Nonroad: Lawn & Garden	10.66	6.84
Nonroad Vehicles & Equip (includes marine)	Nonroad: Logging	1.54	0.39
Nonroad Vehicles & Equip (includes marine)	Nonroad: Recreational	16.42	7.61
Nonroad Vehicles & Equip (includes marine)	Nonroad: Recreational Marine	9.90	6.55
On-Road Mobile	On-Road Mobile	220.39	92.70
Other	Commercial Food Preparation	1.10	1.56
Other	Drycleaning	0.93	1.54
Other	Incineration	1.51	0.37
Other	Municipal (non-TV) Landfills	7.80	11.19
Other	Open Burning: Land Clearing	0.21	4.73
Other	Open Burning: Residential	3.83	6.66
Other	Placeholder	0.01	--
Other	POTWs	1.49	2.21
Other	Prescribed Burning	2.41	2.41
Other	Residential Wood Combustion	9.15	9.52
Other	Stationary Source Fuel Combustion	4.95	5.99
Other	TSDFs	0.00	0.00
Rail	Nonroad: Rail	59.36	44.54
Surface Coating	Surface Coating	19.08	25.64
Total		**936.6**	**754.3**

East of Gorge Anthropogenic Emissions: NH_3 + SO_X + PM_{25} + VOC + NO_X: Tons Per Day

Group	Category	-- November 12th -- 2004	2018
Agriculture	Fertilizer Application	13.78	13.78
Agriculture	Nonroad: Agricultural	14.33	71.15
Agriculture	Open Burning: Agricultural	6.71	6.67
Agriculture	Orchard Heaters	0.67	0.34
Degreasing	Degreasing	3.90	18.96
Fuel Storage, Transport, & Dispensing	Fuel Storage & Transport	14.46	23.90
Fugitive Dust	Fugitive Dust	33.24	0.00
Industrial Point	Industrial Point	117.01	120.90
Livestock Operations	Livestock Operations	63.02	45.35
Misc. Area Sources	Area: Misc. Industrial	10.10	14.59
Misc. Area Sources	Graphic Arts	2.60	3.44
Misc. Area Sources	Misc. Area Sources	7.92	7.37
Misc. Area Sources	Misc. Non-Industrial Solvent Utilization	22.07	54.79
Nonroad Vehicles & Equipment (incl. Marine)	Nonroad: Aircraft & Aircraft Refueling	0.74	0.82
Nonroad Vehicles & Equipment (incl. Marine)	Nonroad: Airport GSE	0.02	0.01
Nonroad Vehicles & Equipment (incl. Marine)	Nonroad: CMV	4.93	4.85
Nonroad Vehicles & Equipment (incl. Marine)	Nonroad: Commercial	3.99	2.63
Nonroad Vehicles & Equipment (incl. Marine)	Nonroad: Construction & Mining	12.70	10.37
Nonroad Vehicles & Equipment (incl. Marine)	Nonroad: Diesel	0.00	--
Nonroad Vehicles & Equipment (incl. Marine)	Nonroad: Industrial	3.97	1.08
Nonroad Vehicles & Equipment (incl. Marine)	Nonroad: Lawn & Garden	3.66	6.84
Nonroad Vehicles & Equipment (incl. Marine)	Nonroad: Logging	1.57	0.39
Nonroad Vehicles & Equipment (incl. Marine)	Nonroad: Recreational	15.18	7.61
Nonroad Vehicles & Equipment (incl. Marine)	Nonroad: Recreational Marine	4.03	6.55
On-Road Mobile	On-Road Mobile	229.61	96.60
Other	Commercial Food Preparation	1.10	1.56
Other	Drycleaning	0.93	1.54
Other	Incineration	1.51	0.37
Other	Municipal (non-TV) Landfills	7.80	11.19
Other	Open Burning: Land Clearing	0.23	5.39
Other	Open Burning: Residential	3.90	6.75
Other	Placeholder	0.01	--
Other	POTWs	1.49	2.21
Other	Residential Wood Combustion	90.48	94.20
Other	Stationary Source Fuel Combustion	9.83	9.76
Other	TSDFs	0.00	0.00
Prescribed Burning	Prescribed Burning	174.24	174.24
Rail	Nonroad: Rail	59.37	44.54
Surface Coating	Surface Coating	19.06	25.63
		960.2	**896.4**

APPENDIX B

County Charts of Emissions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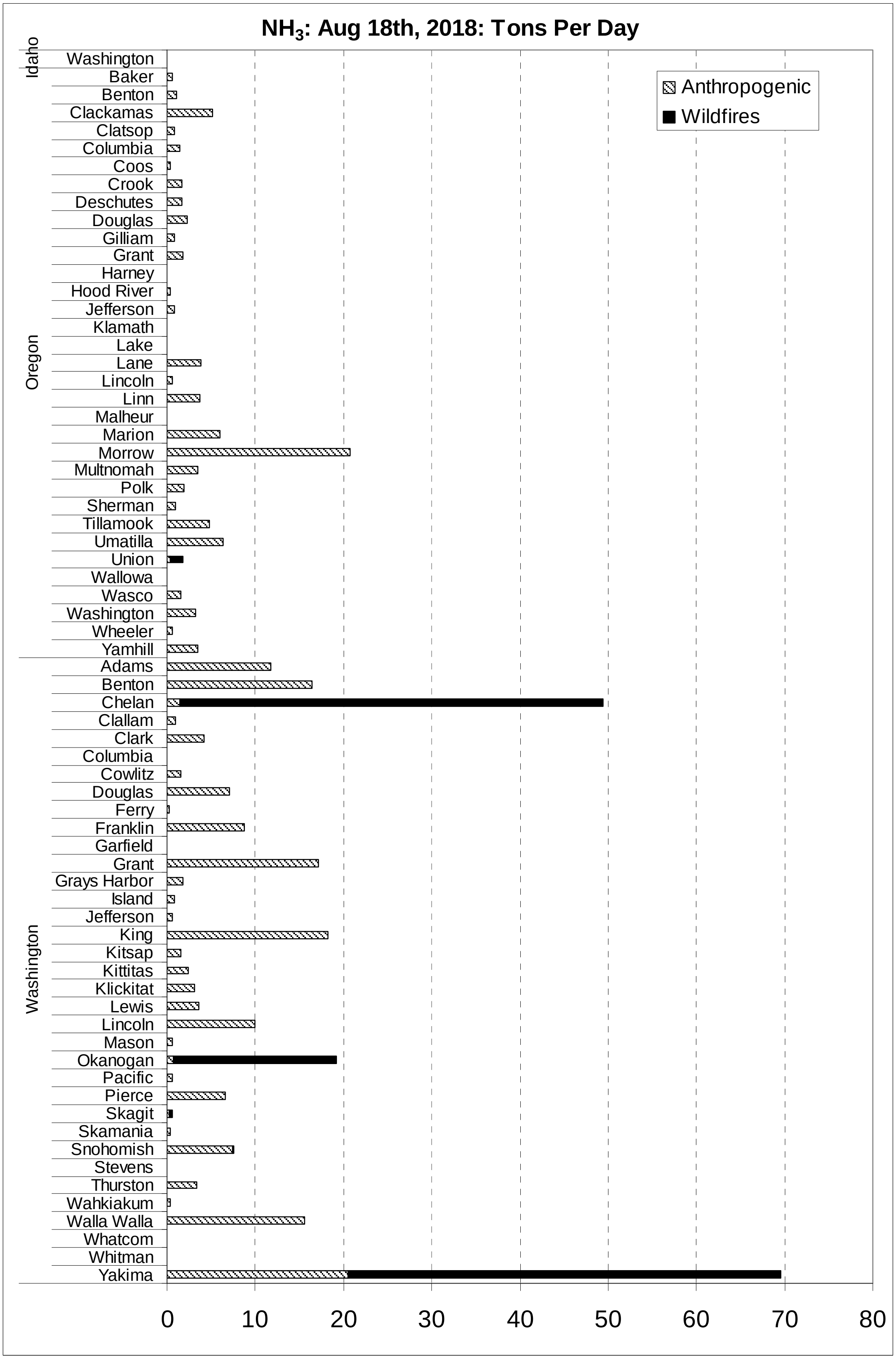

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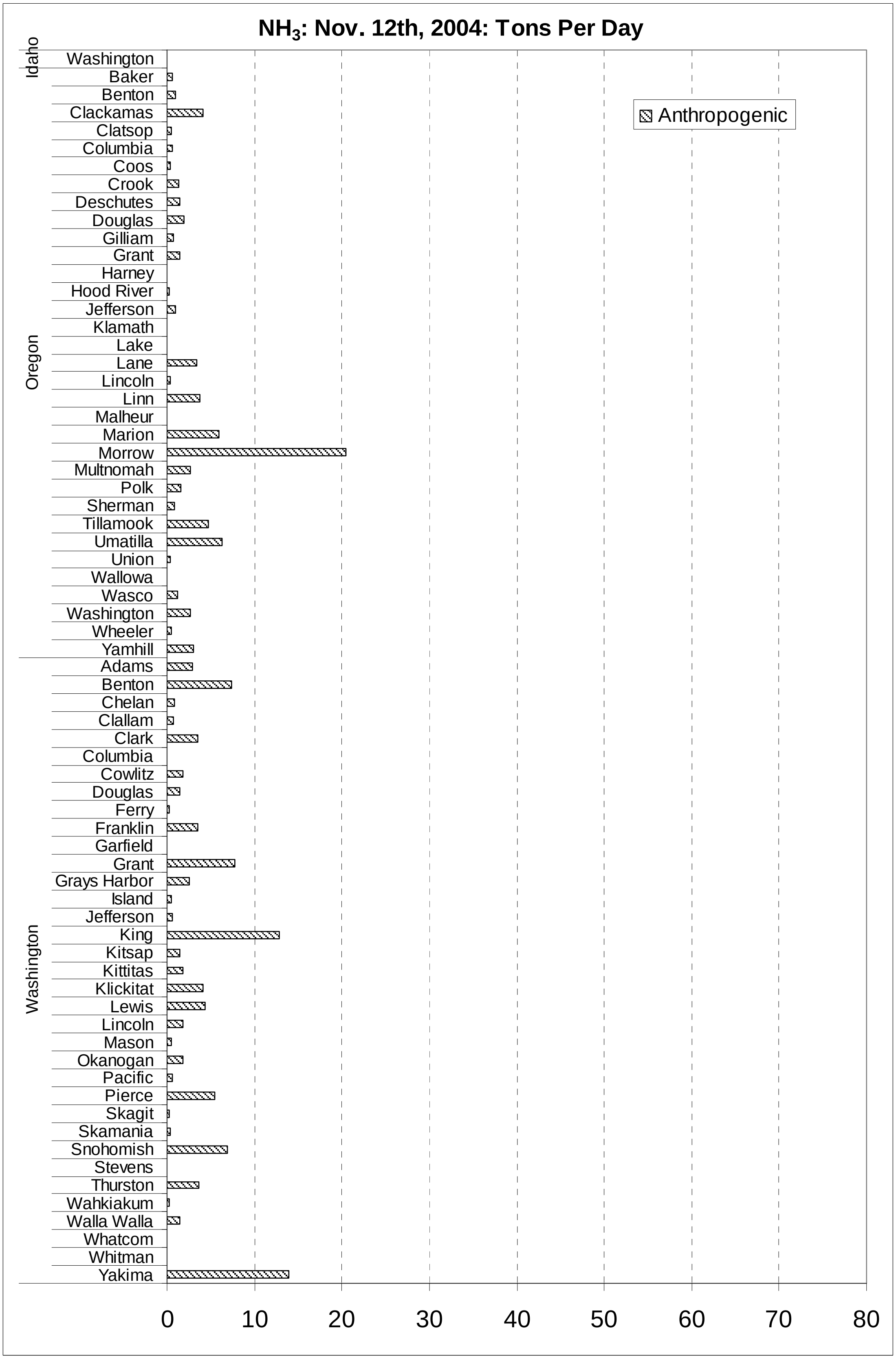

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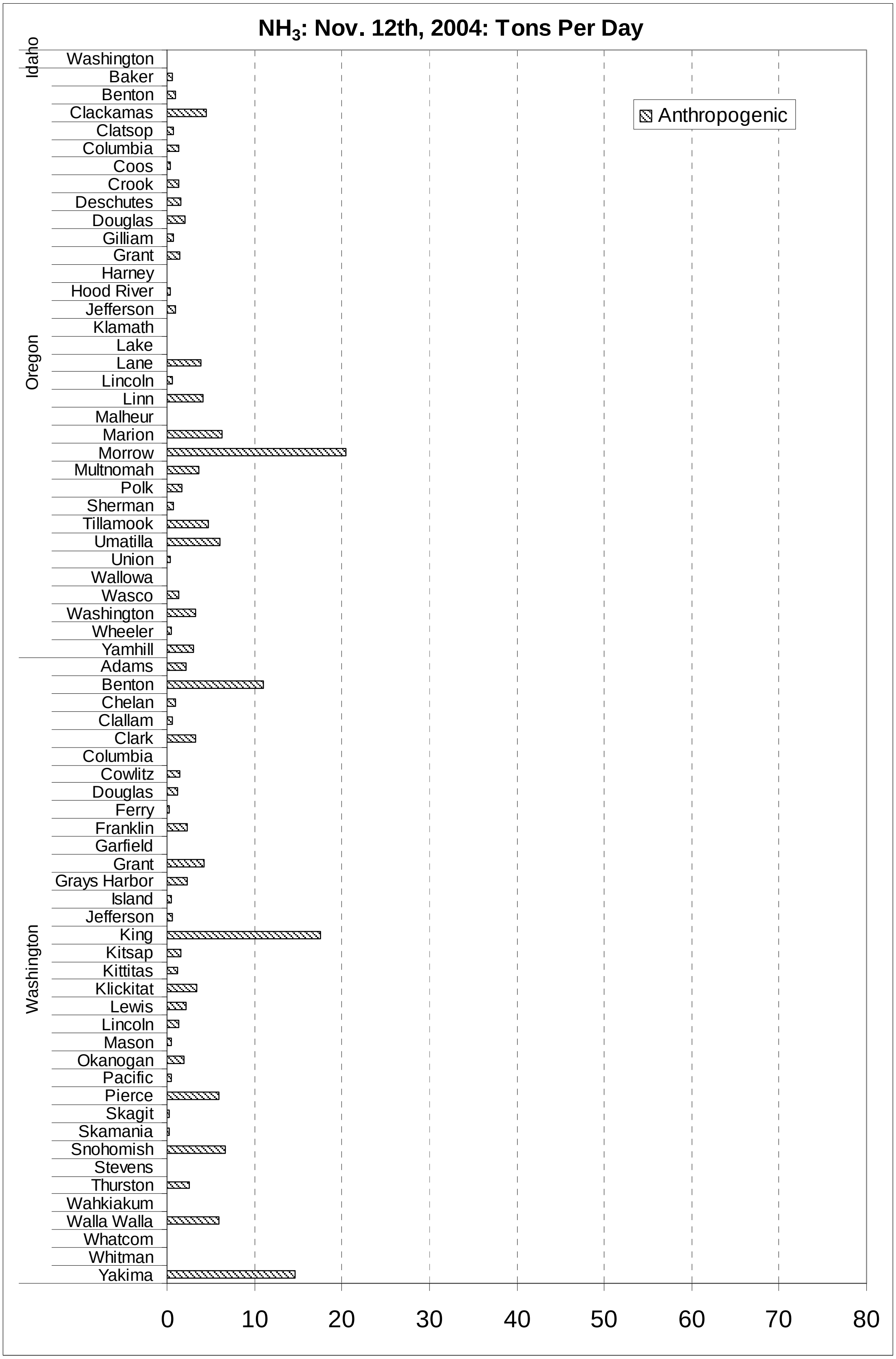

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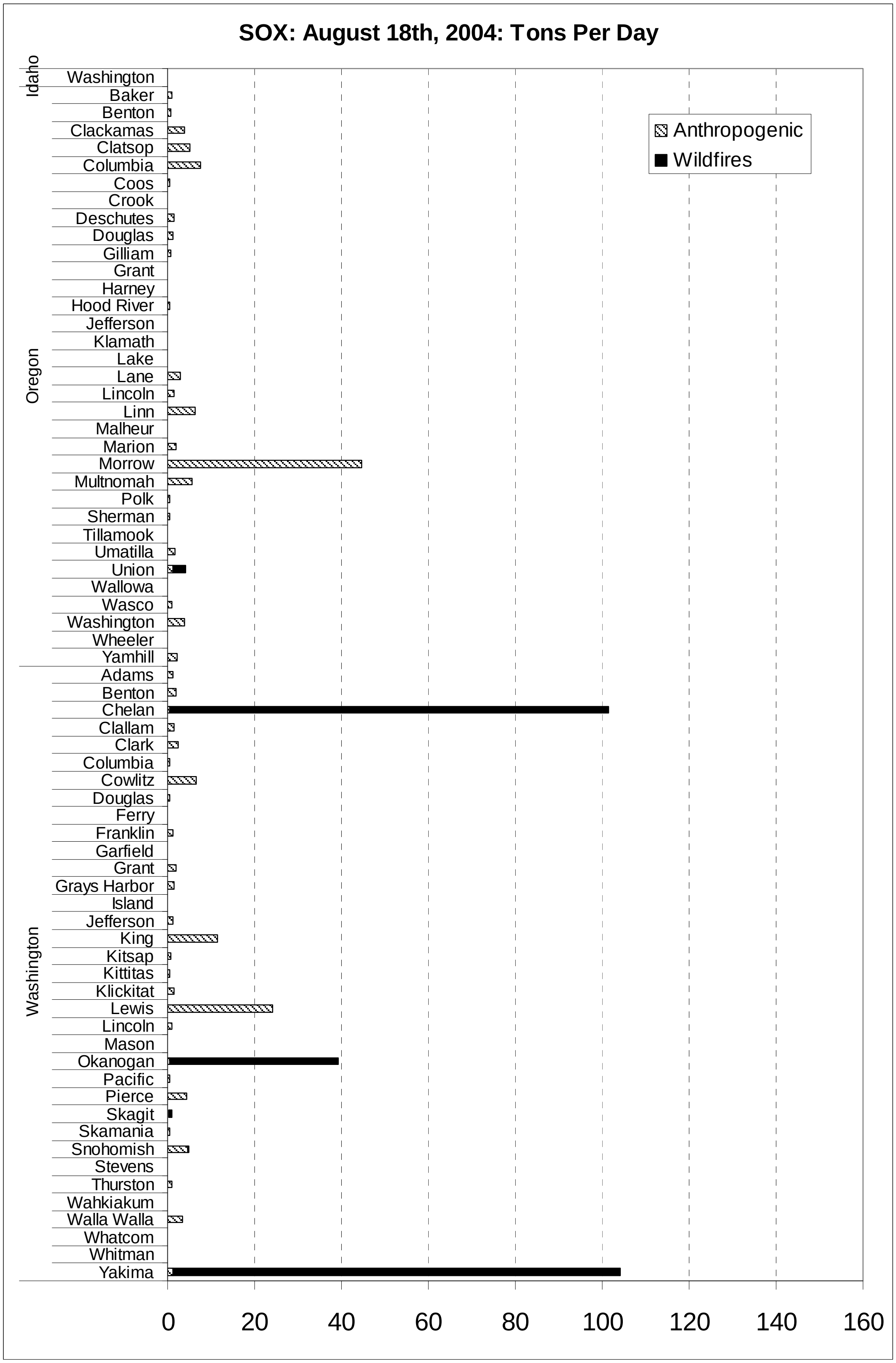
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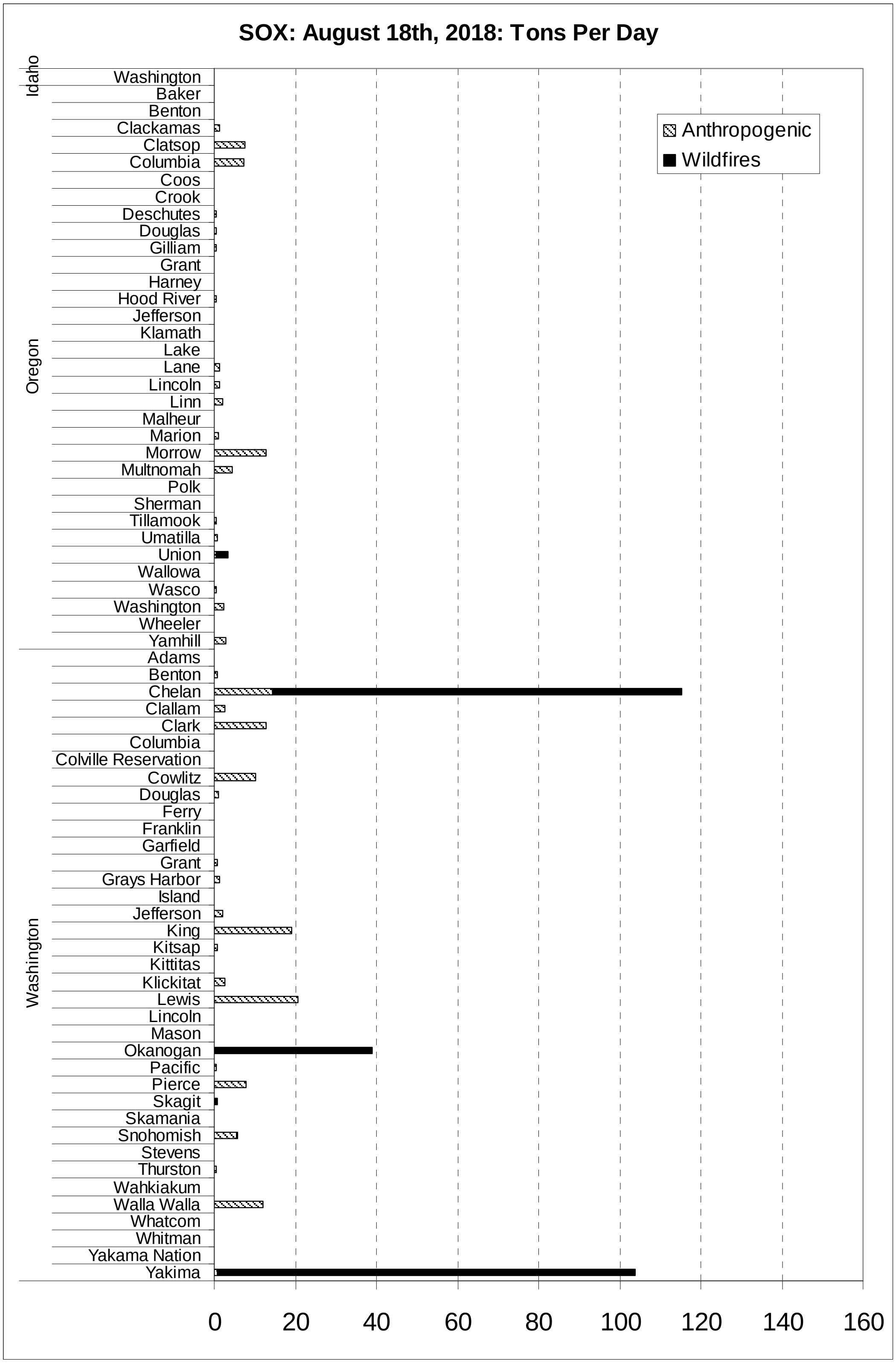
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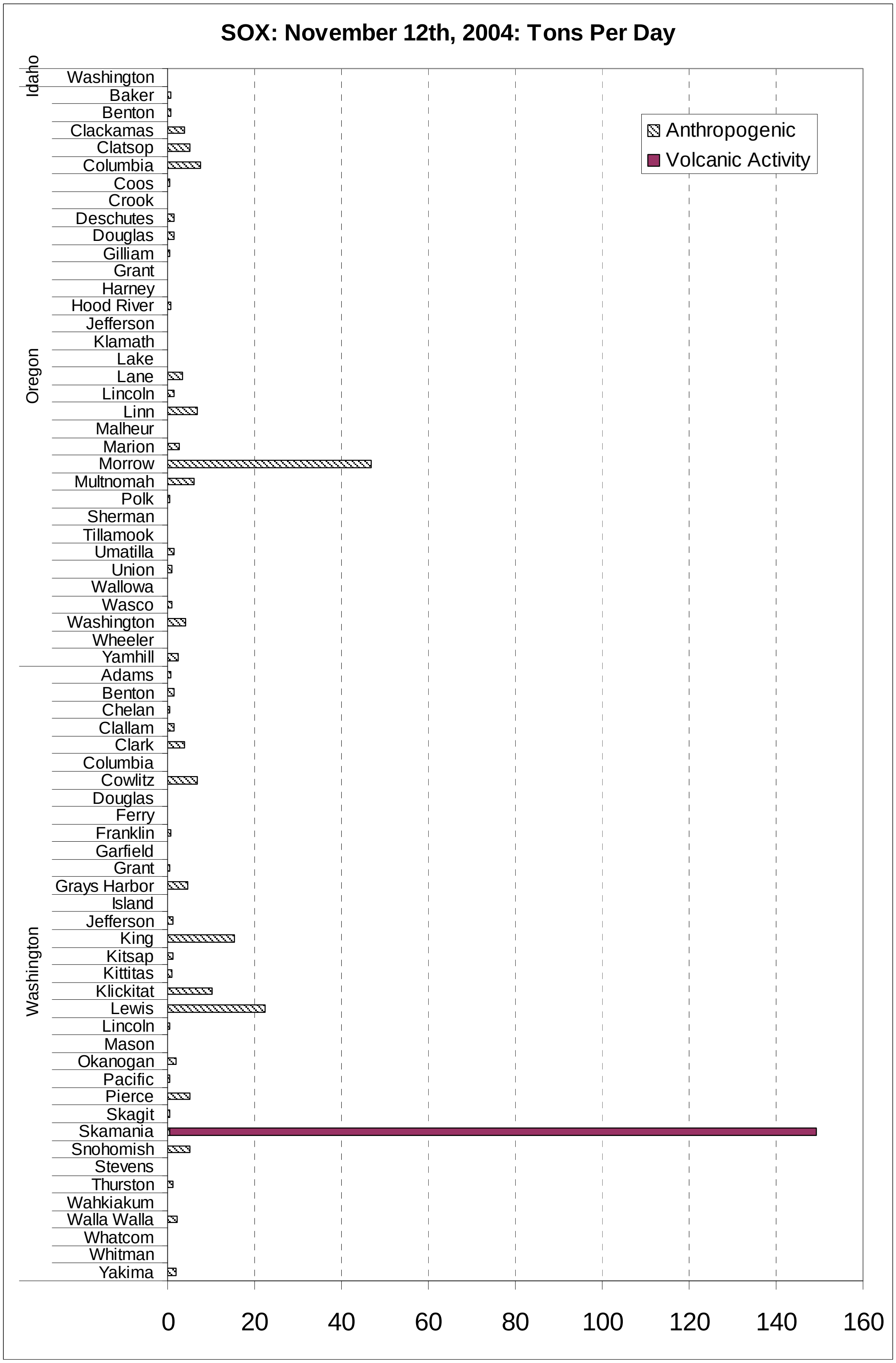

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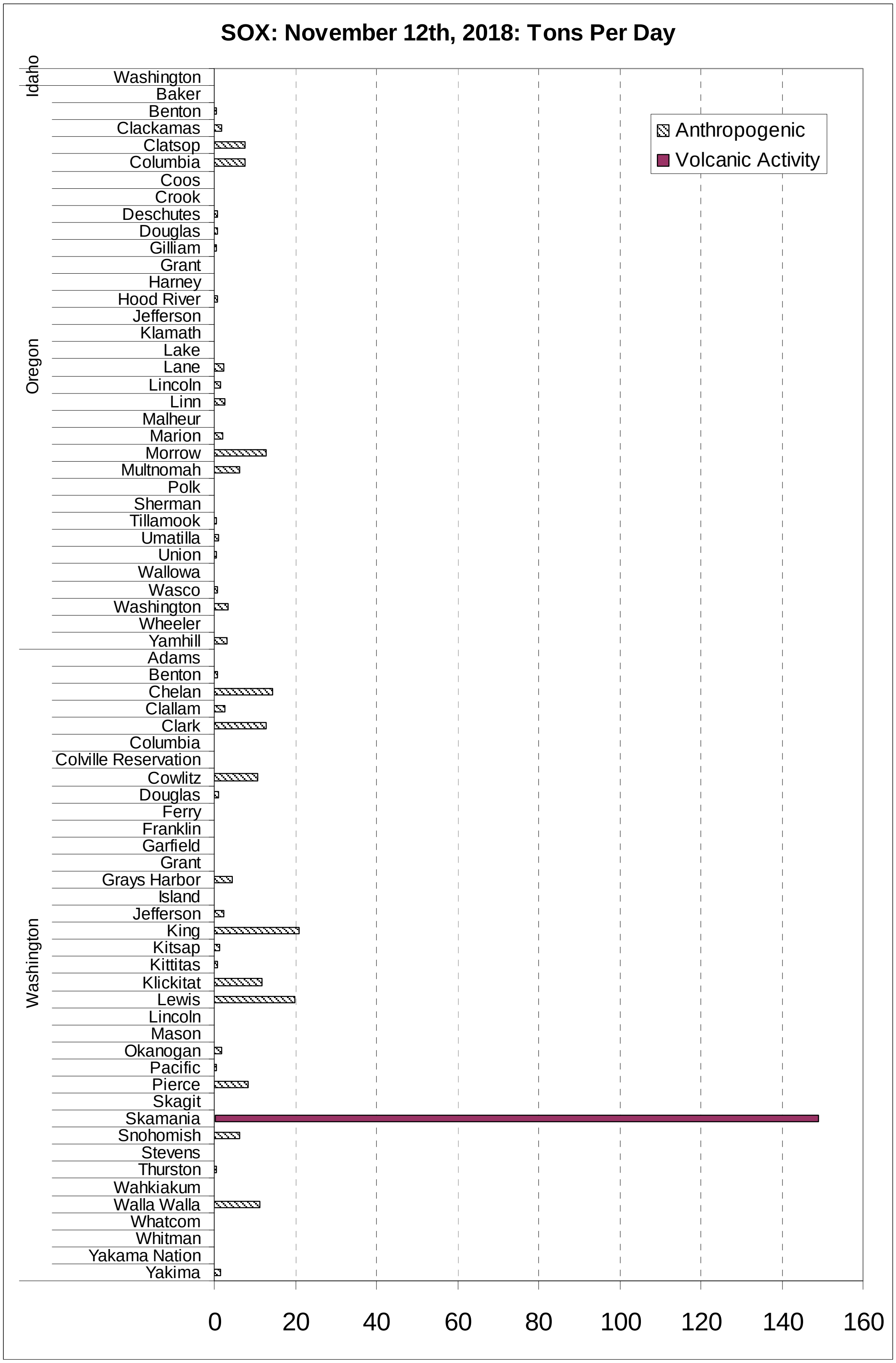

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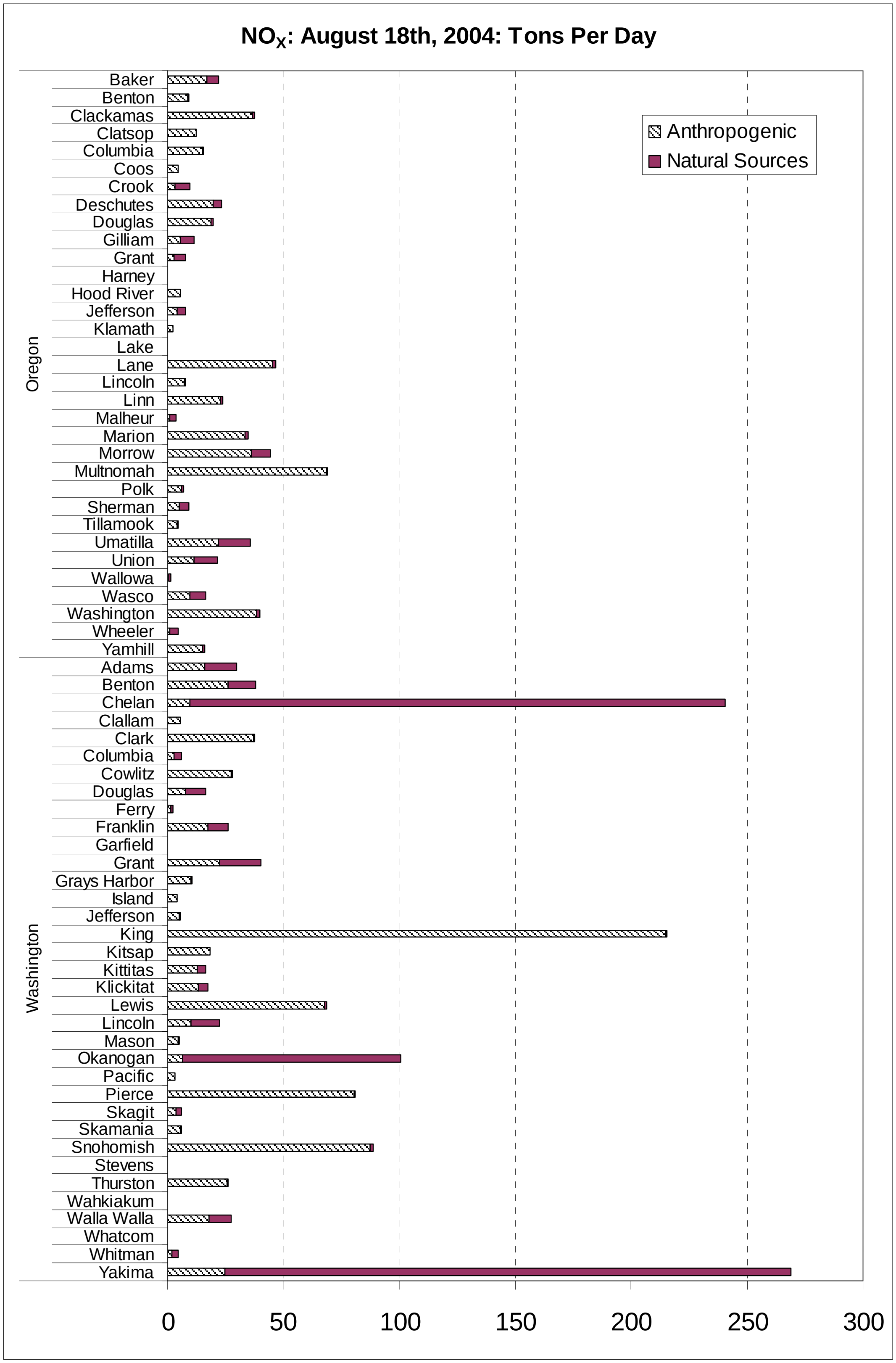

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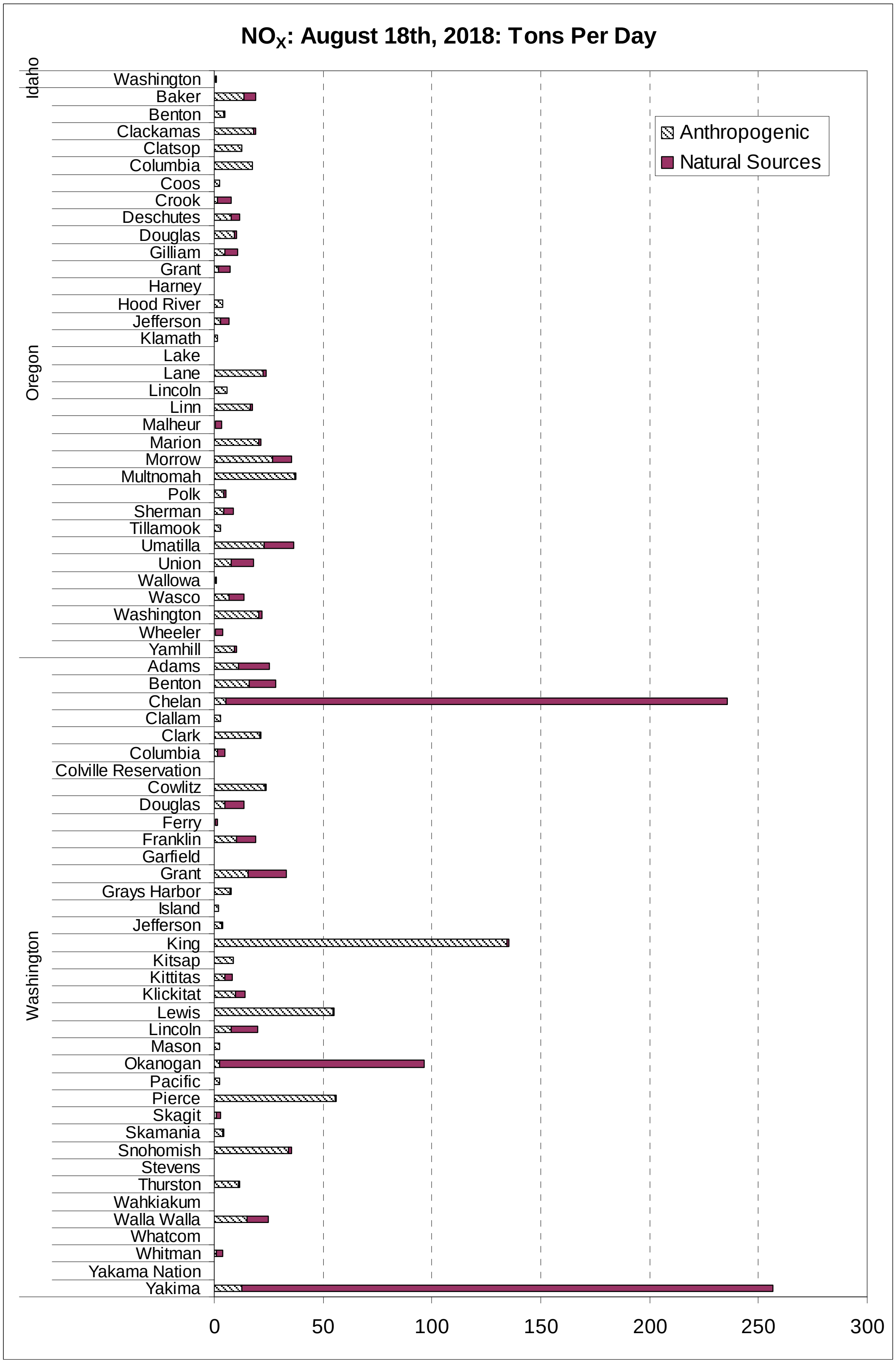
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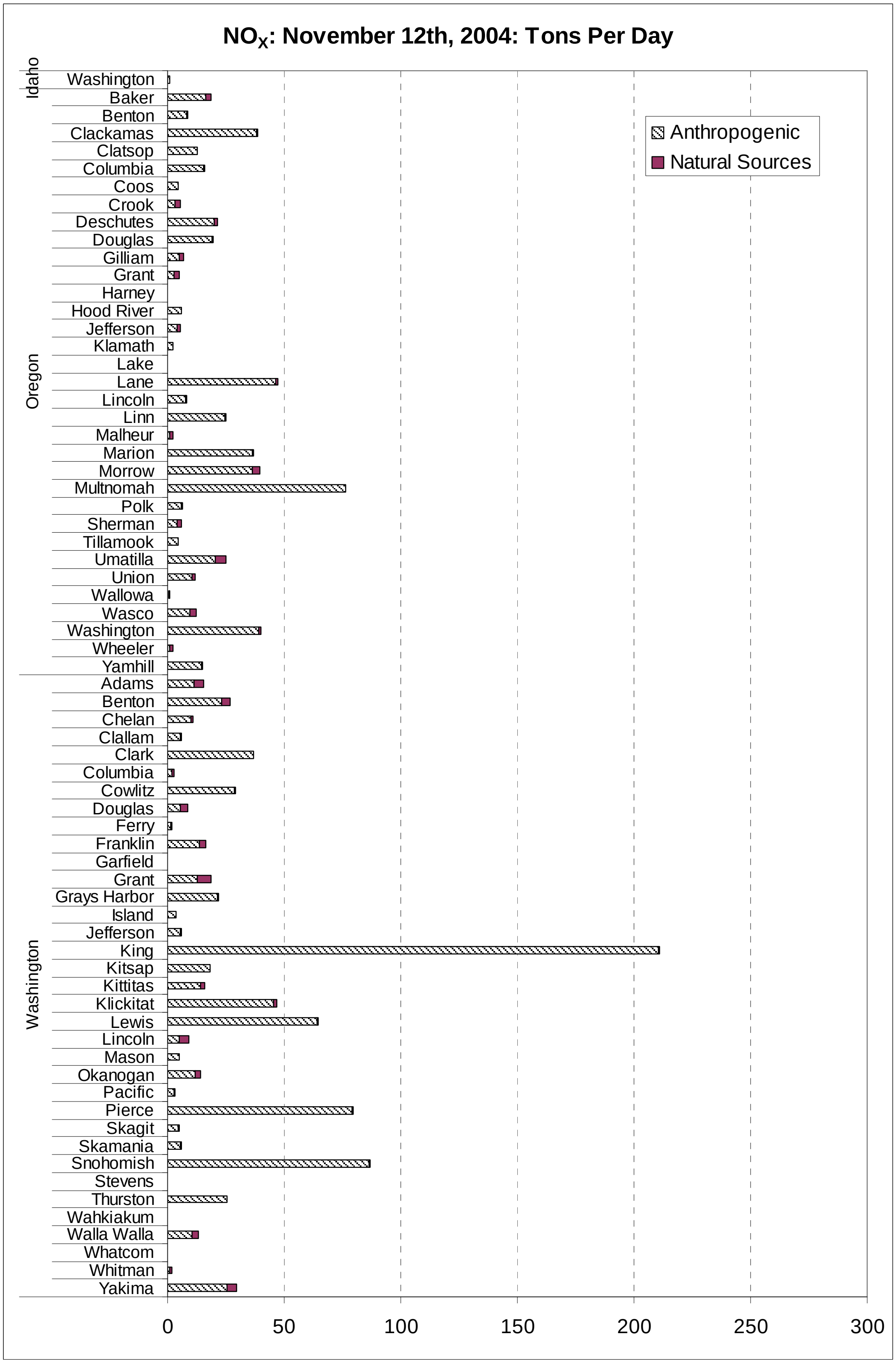

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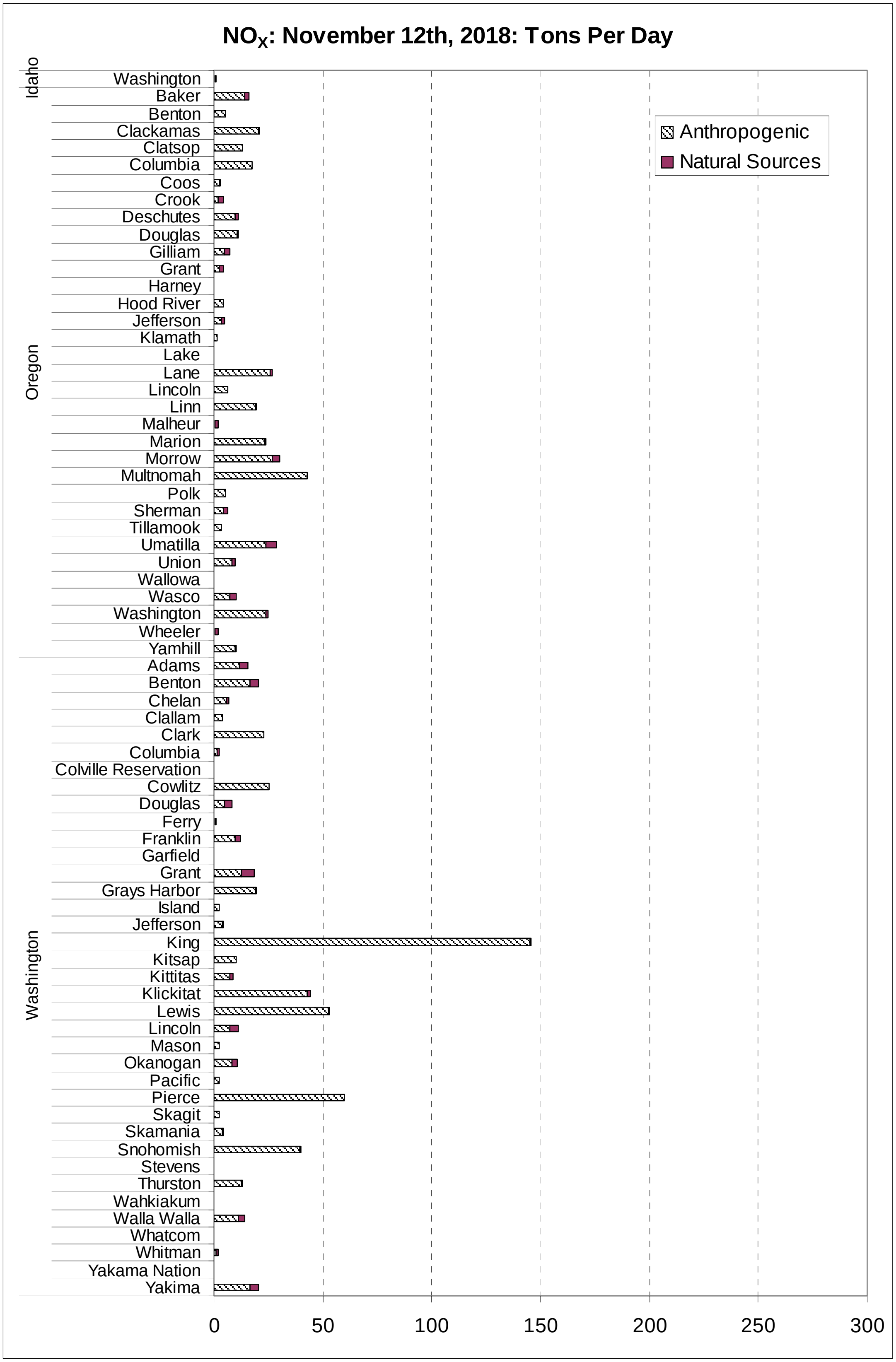
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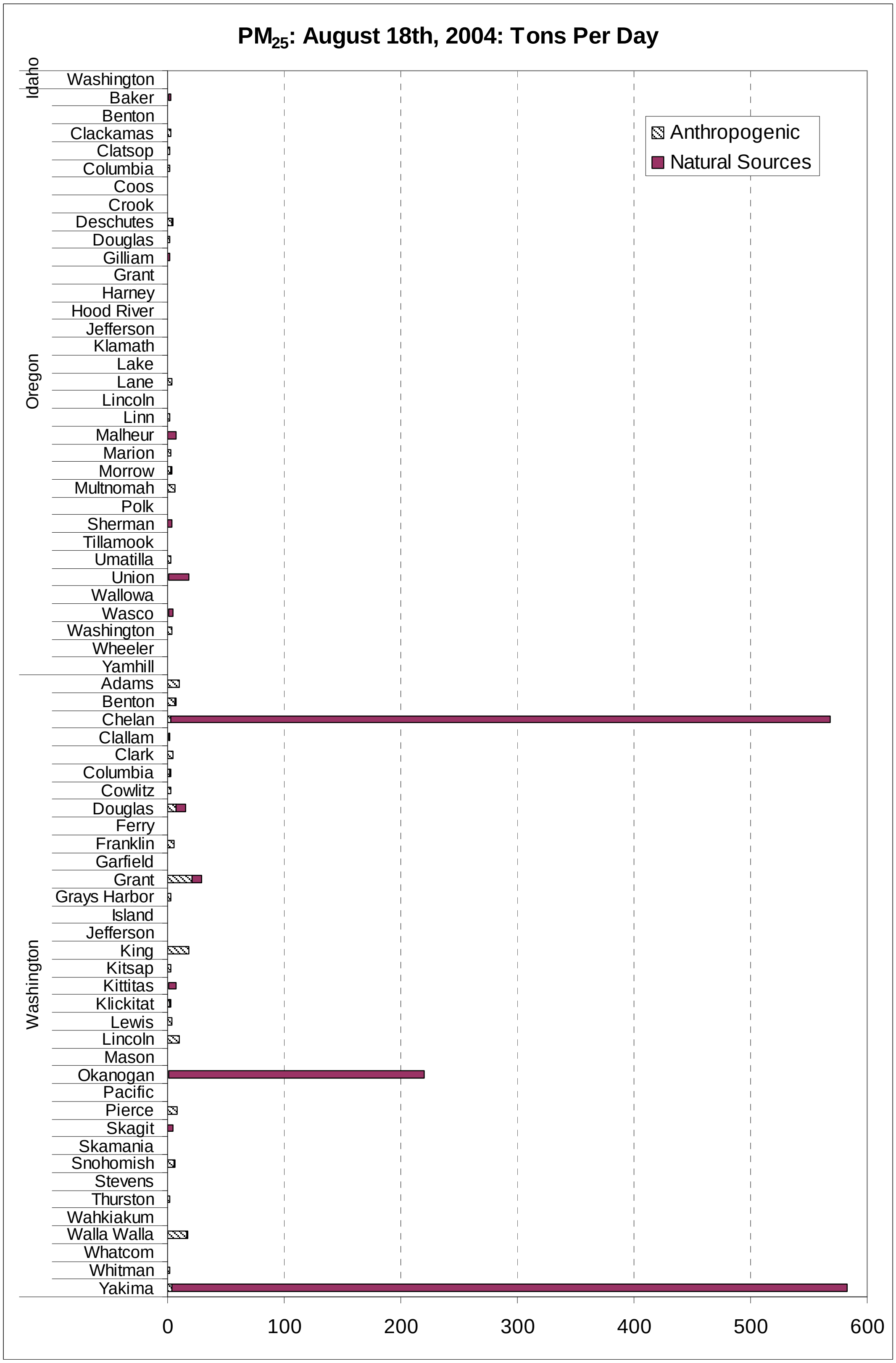

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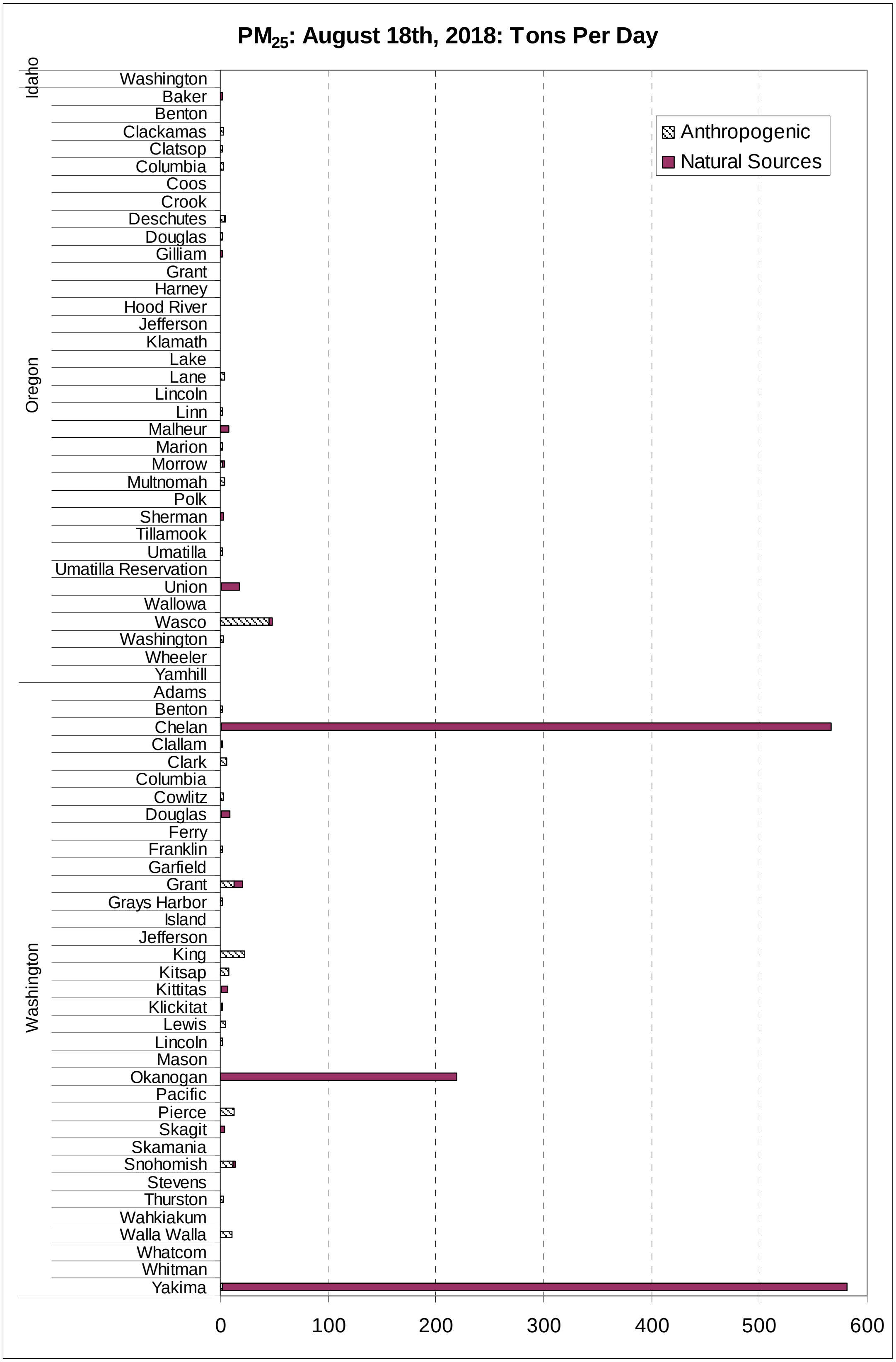
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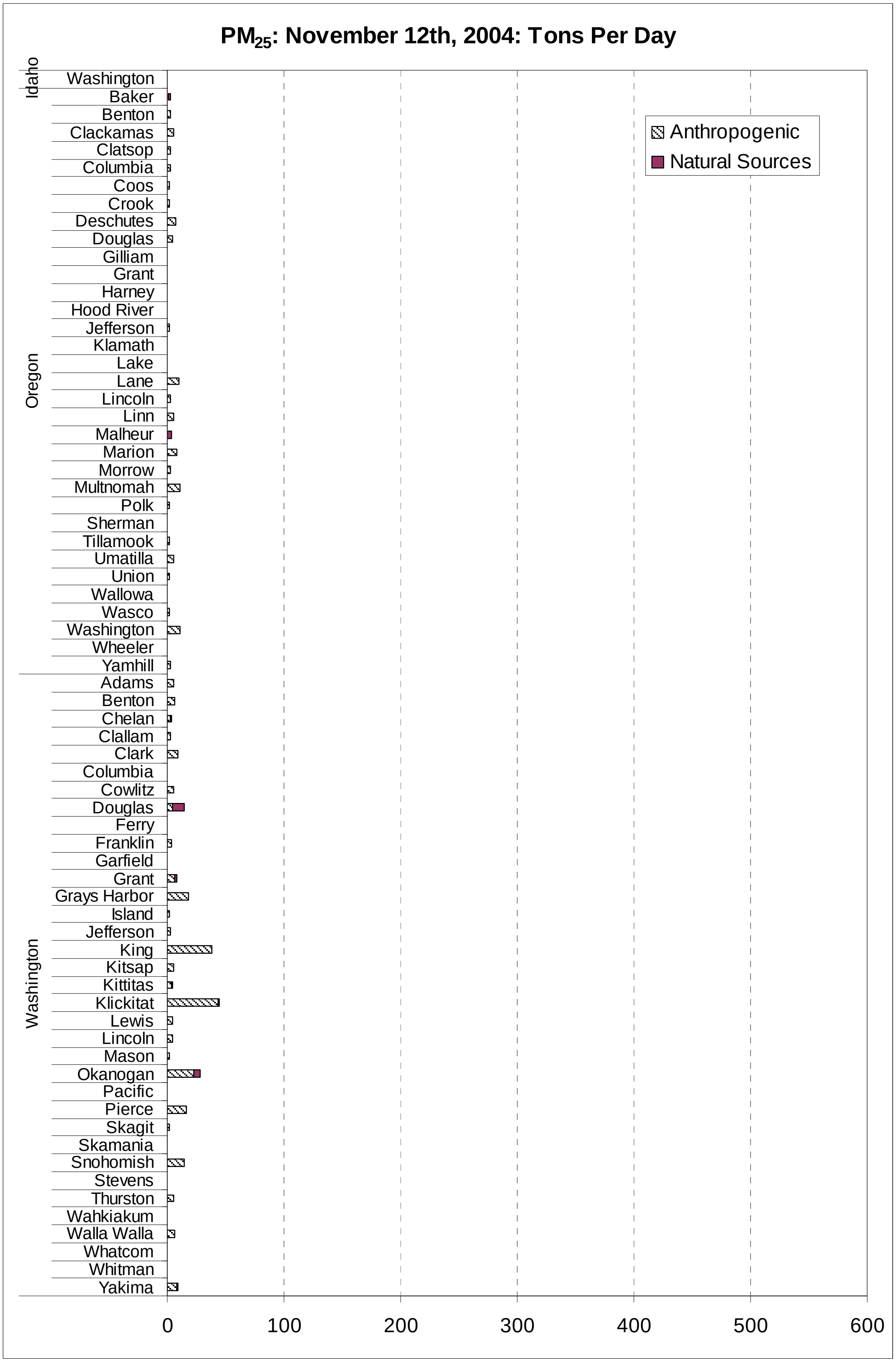
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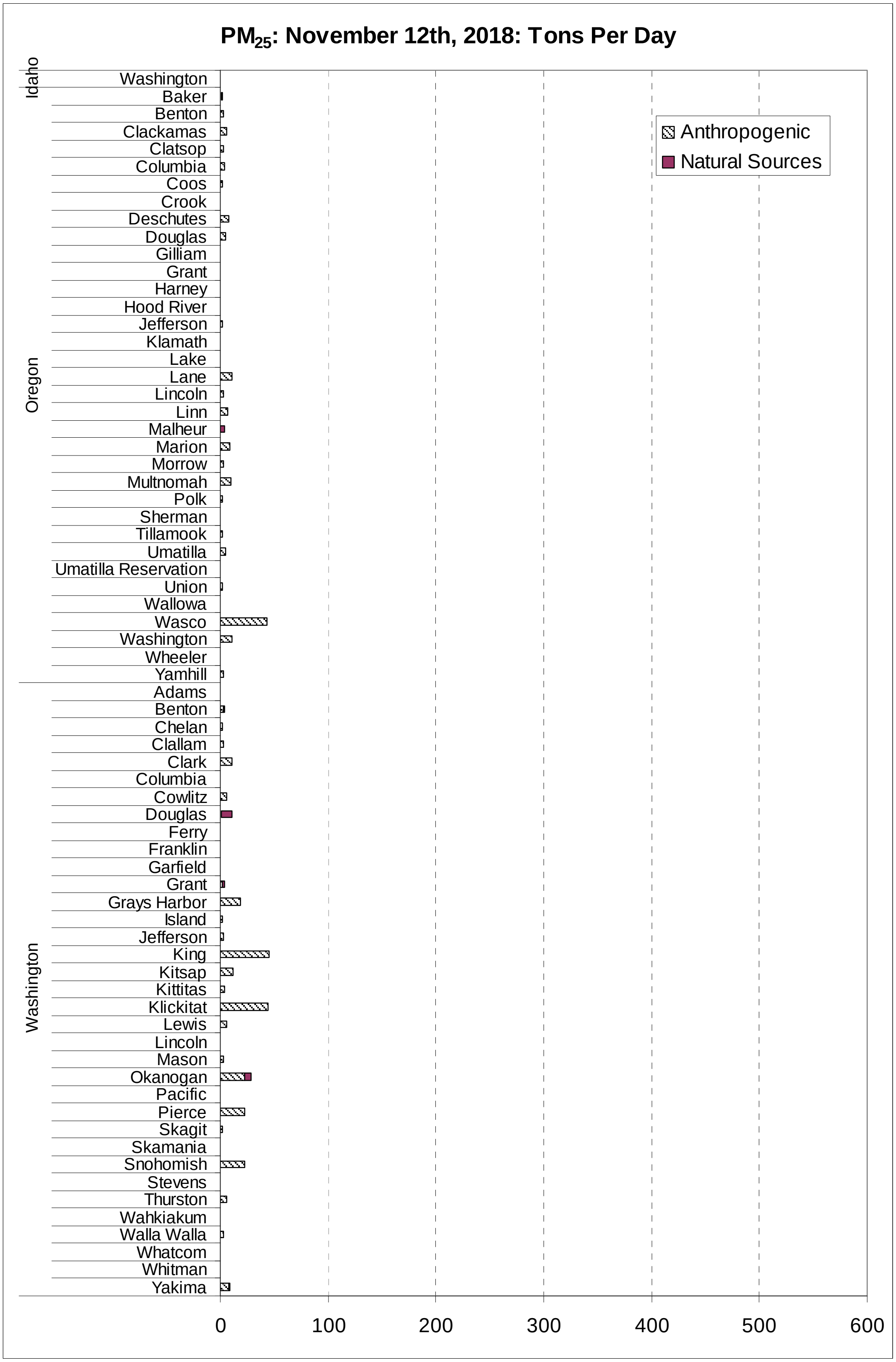
PM25: November 12th, 2018: Tons Per Day
Anthropogenic
Natural Sources
Idaho
Washington
Oregon
Baker
Benton
Clackamas
Clatsop
Columbia
Coos
Crook
Deschutes
Douglas
Gilliam
Grant
Harney
Hood River
Jefferson
Klamath
Lake
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Lincoln
Linn
Malheur
Marion
Morrow
Multnomah
Polk
Sherman
Tillamook
Umatilla
Umatilla Reservation
Union
Wallowa
Wasco
Washington
Wheeler
Yamhill
Washington
Adams
Benton
Chelan
Clallam
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Columbia
Cowlitz
Douglas
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Franklin
Garfield
Grant
Grays Harbor
Island
Jefferson
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Kittitas
Klickitat
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Skamania
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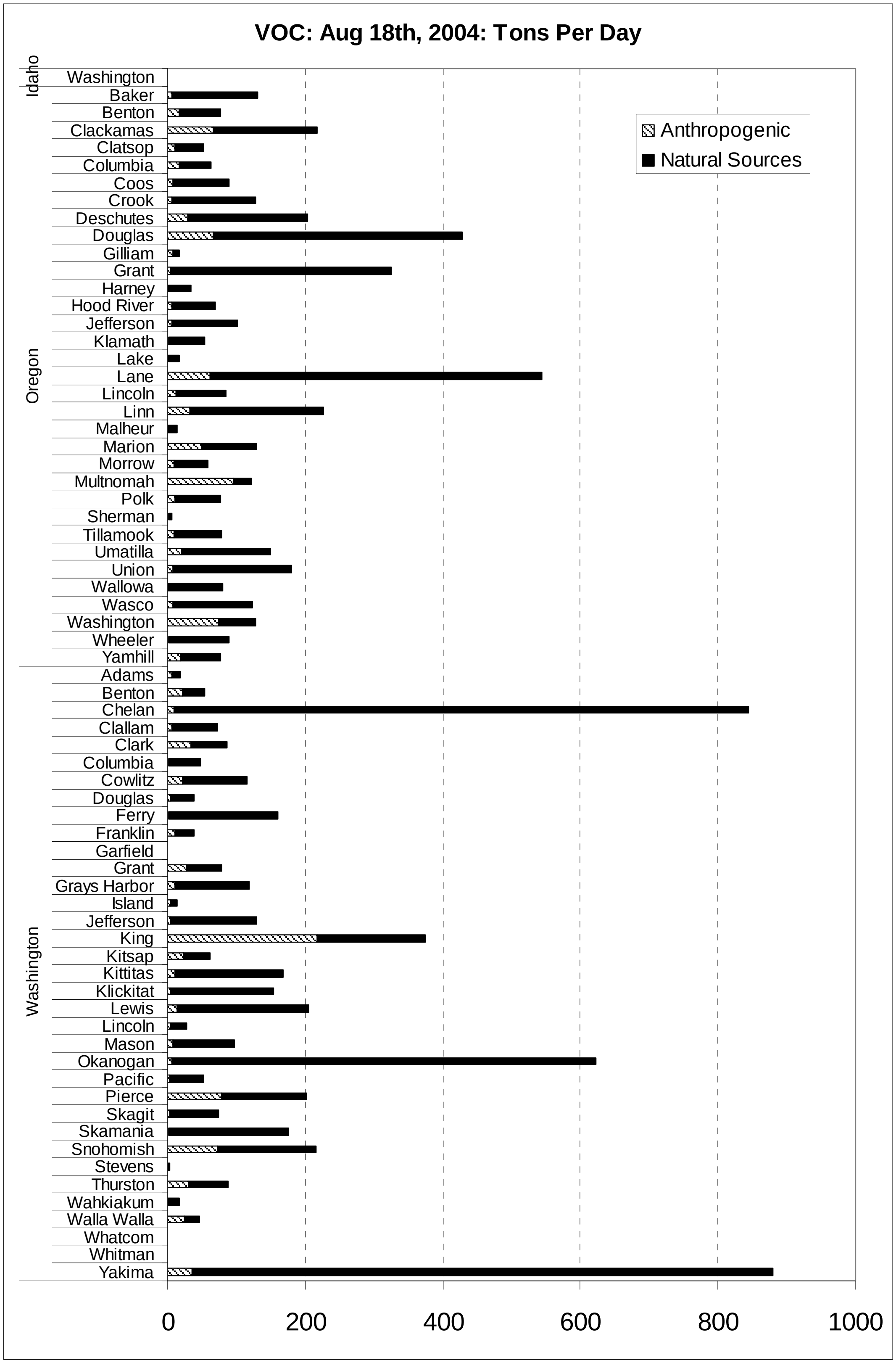

VOC: Aug 18th, 2004: Tons Per Day
Anthropogenic
Natural Sources
Idaho
Washington
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Clatsop
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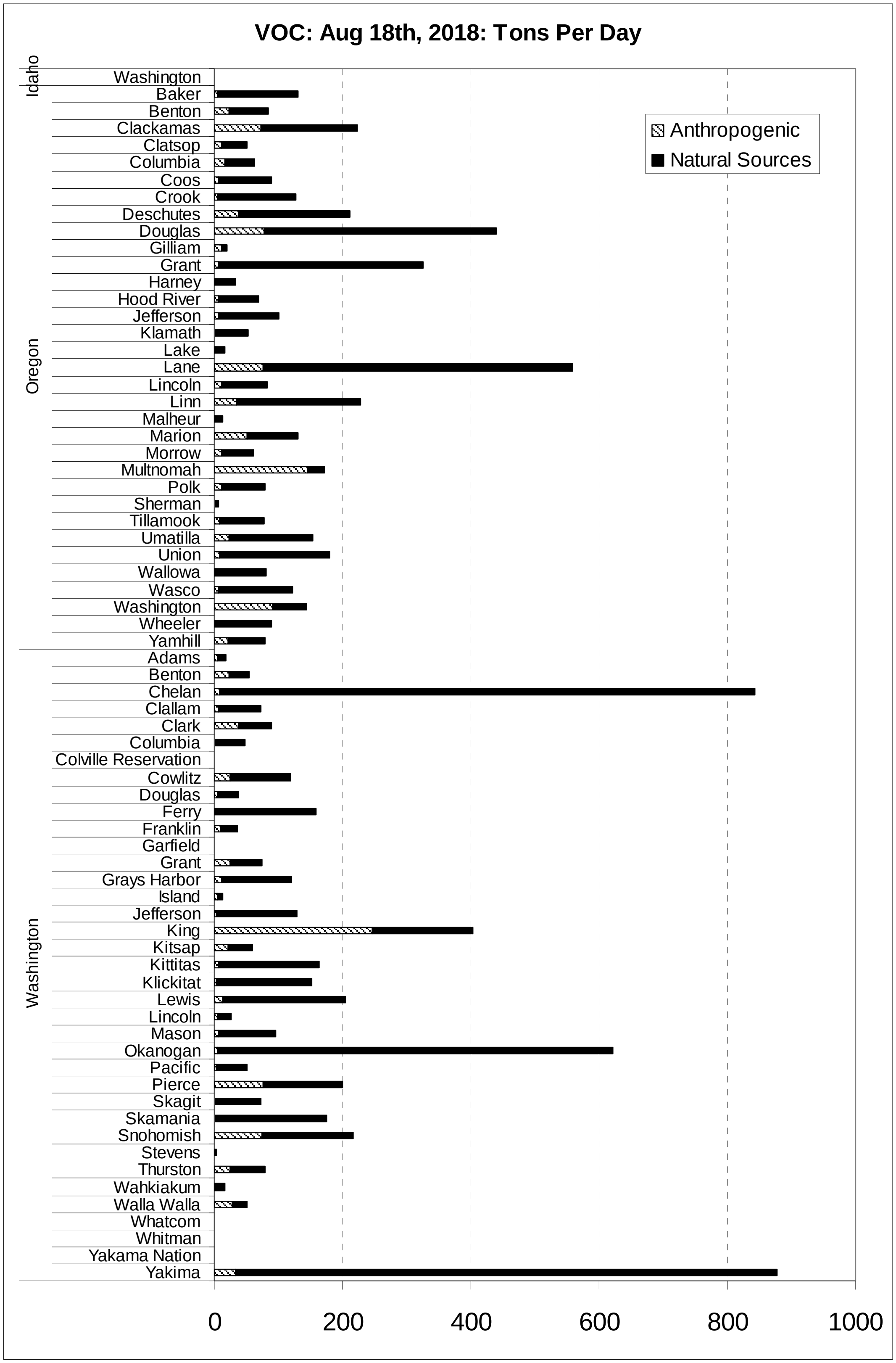

VOC: Aug 18th, 2018: Tons Per Day
Anthropogenic
Natural Sources
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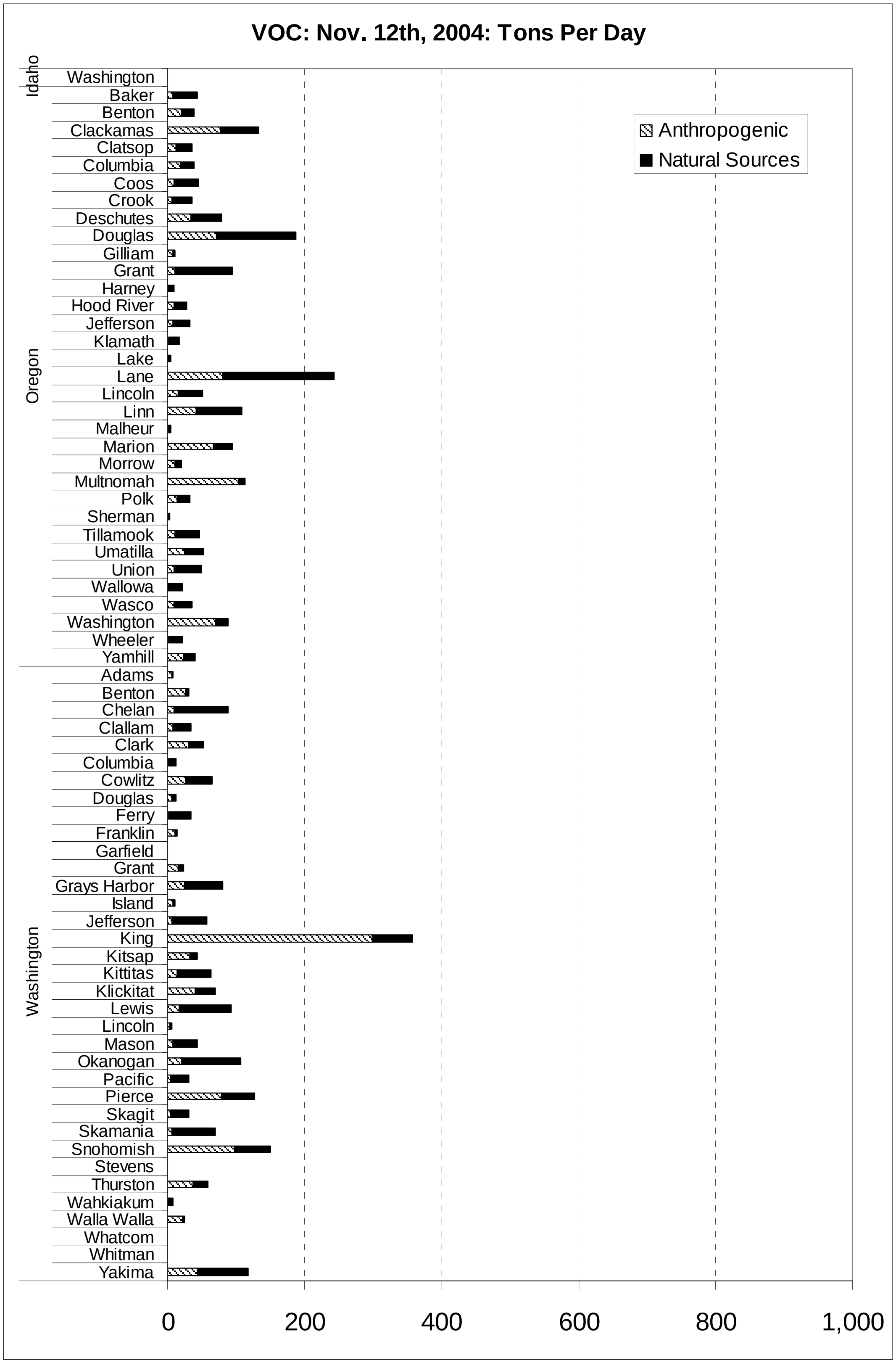
VOC: Nov. 12th, 2004: Tons Per Day
Anthropogenic
Natural Sources
Idaho
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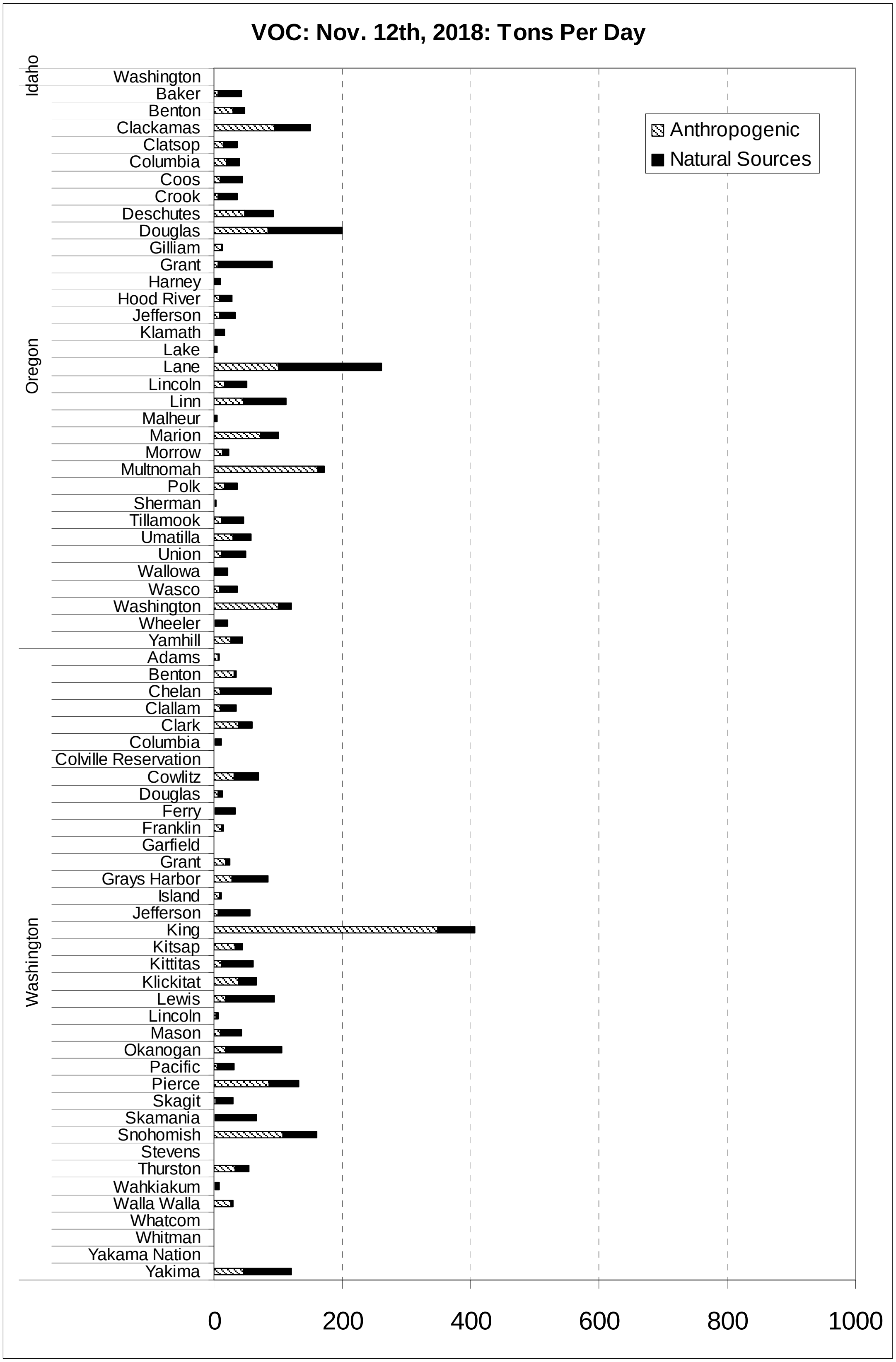
VOC: Nov. 12th, 2018: Tons Per Day
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