Oregon DEQ AQ Planning & Tech. Services

2014 Portland Oregon Residential Wood Combustion Survey: Results Summary and $PM_{2.5}$ Emissions Estimates

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Portland, OR

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Overview

- Survey need
- Survey method
- Results
  - Respondents and wood heating devices
  - Amount of wood fuel burned
  - $PM_{2.5}$ emissions estimates
  - Spatial allocation of emissions
- Conclusions
- Questions & contact info

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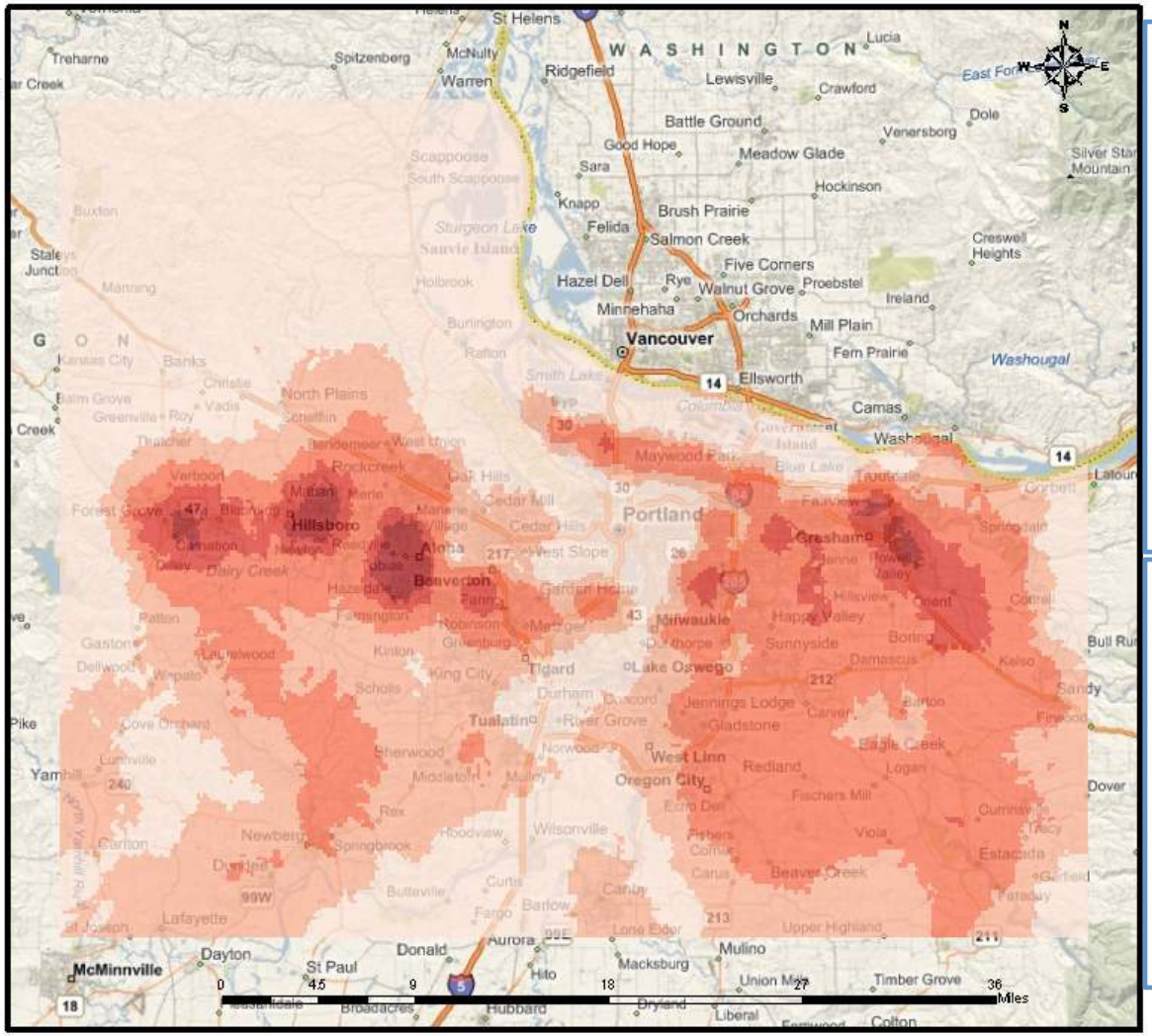
Portland Air Toxics Solutions (PATS) Project

PATS 2017
MODELING RESULTS

Residential Wood Combustion



Times above ABC

- 0 - 1
- 2 - 10
- 11 - 15
- 16 - 25
- 26 - 35
- 36 - 50

References:
Concentration data from DEQ Portland Air Toxics Solution (PATS) study
Basemaps from Metro and ESRI

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Recommendations for next steps to decrease pollution from residential wood burning include:
Conduct a residential wood heating survey to refine DEQ emission estimates

Intention: design the survey to better define emissions from primary heating vs.
secondary burning (backup heating, aesthetics)

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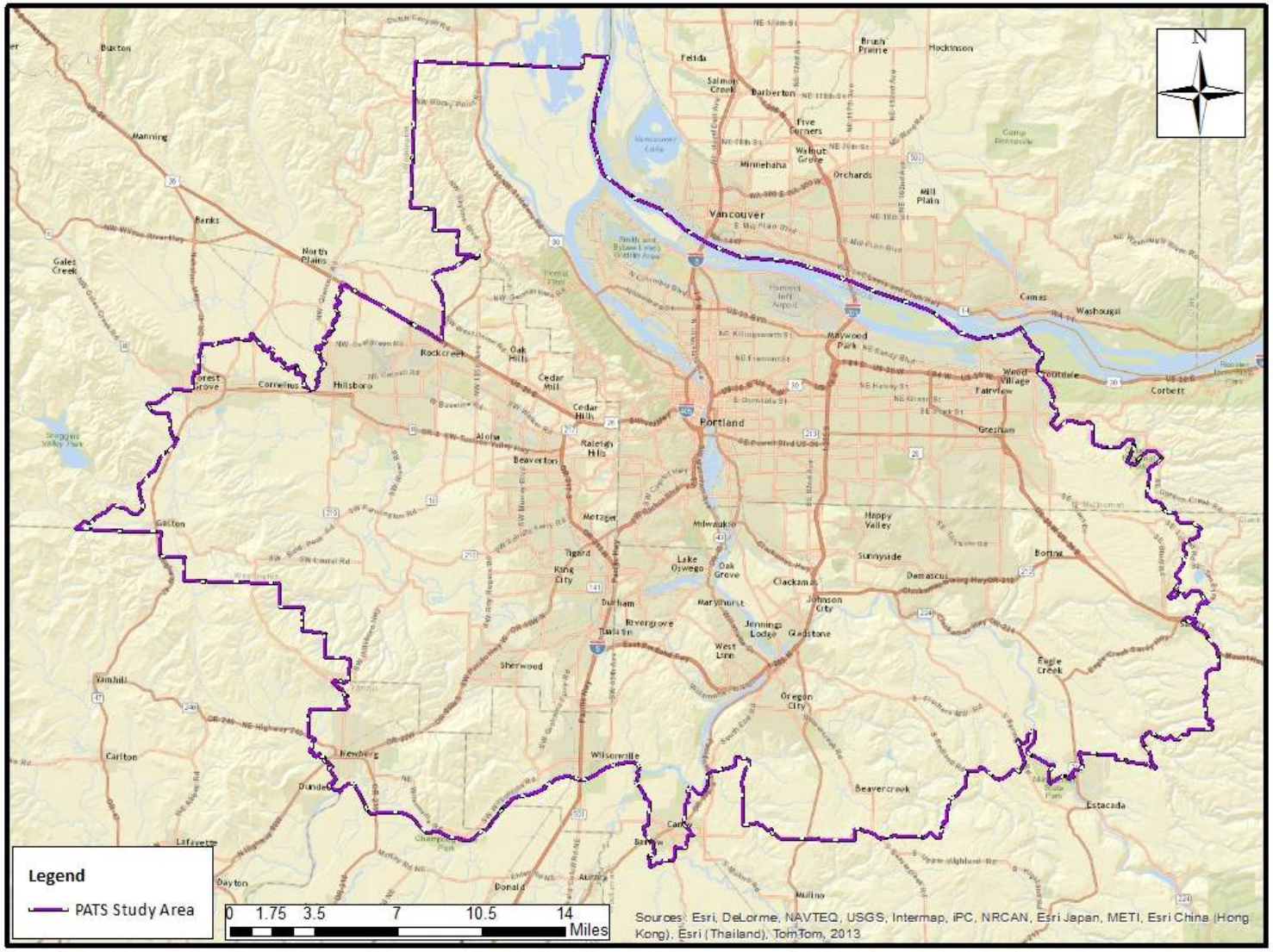
PATS study area = survey area



\\deqhq1\EI_FILES\Residential_Wood_Combustion\RWC & Open Burning Surveys\PATS_RWC_Survey\FollowUp_Survey\Emission_Inventory\FINAL_DATA\Final_GIS\PATS_RWC_FollowUpSurvey_Final_GIS_Granular4_paper.mxd
CLS, 3/26/15

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2014 survey development

- Survey instrument developed by DEQ with contracted assistance from Portland State University Survey Research Lab (SRL)
- Survey conducted by the SRL
- Random household phone survey: CATI
- Questions asked include wood use and demographics

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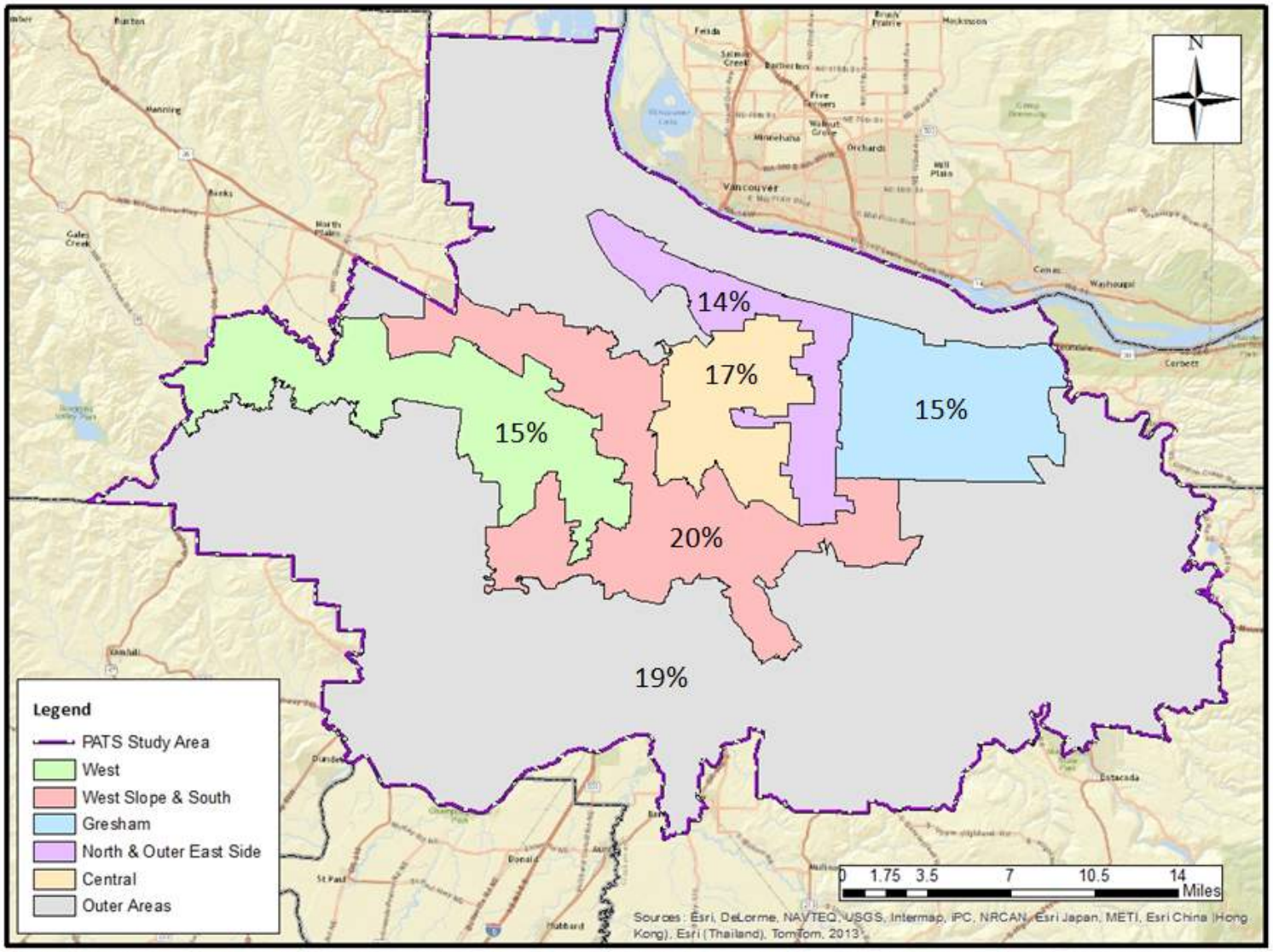
Survey design: sub-areas



Sub-areas delineated by DEQ staff using local knowledge of demographics

Percentages represent the sub-area percent of the total occupied housing units (HU) within the study area

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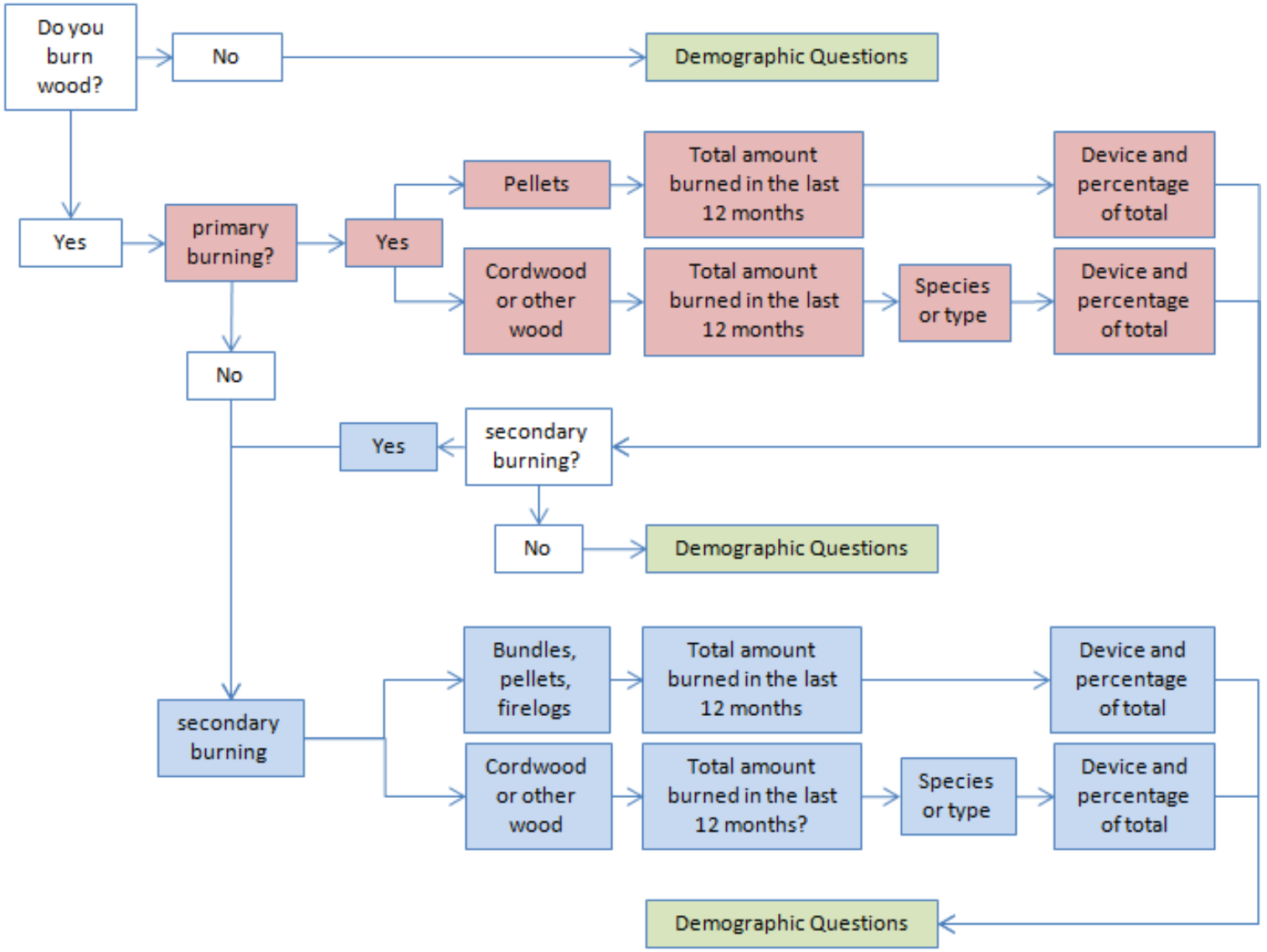
Survey Instrument: Simplified flow-chart



Number of completed surveys

Subarea	Original Completed Survey Goal	Final Completed Survey Count
Subarea 1: West	176	175
Subarea 2: West Slope and South	176	175
Subarea 3: Central	176	173
Subarea 4: North and Outer Eastside	176	175
Subarea 5: Gresham	176	176
Subarea 6: Outer Areas	176	187
Completed Surveys Used for Analysis	1,056	**1,061**
Outside Study Area		7
Not Enough Data to Locate		5

TOTAL		1,073

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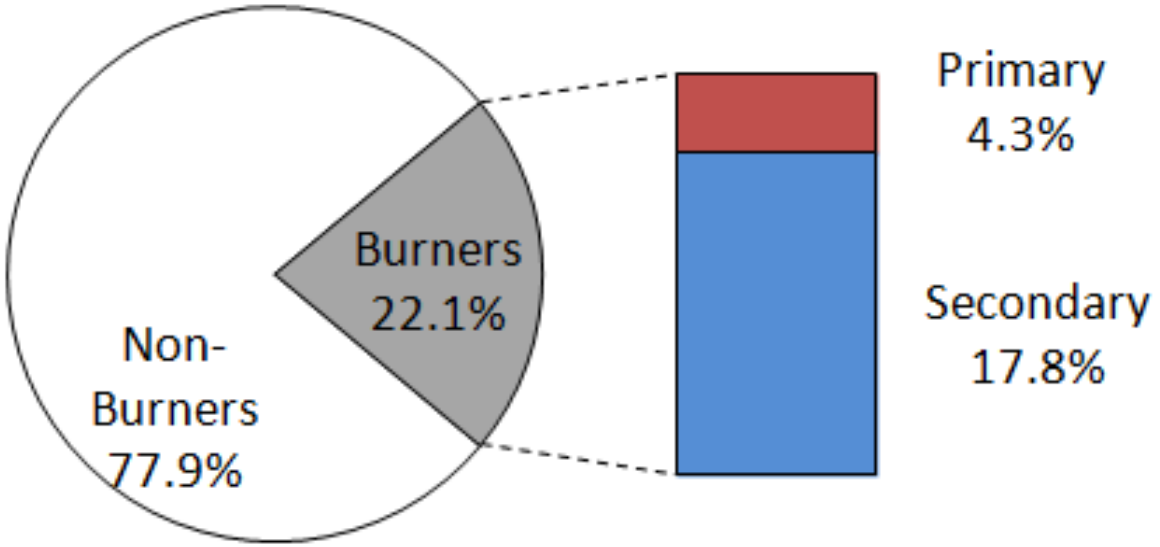
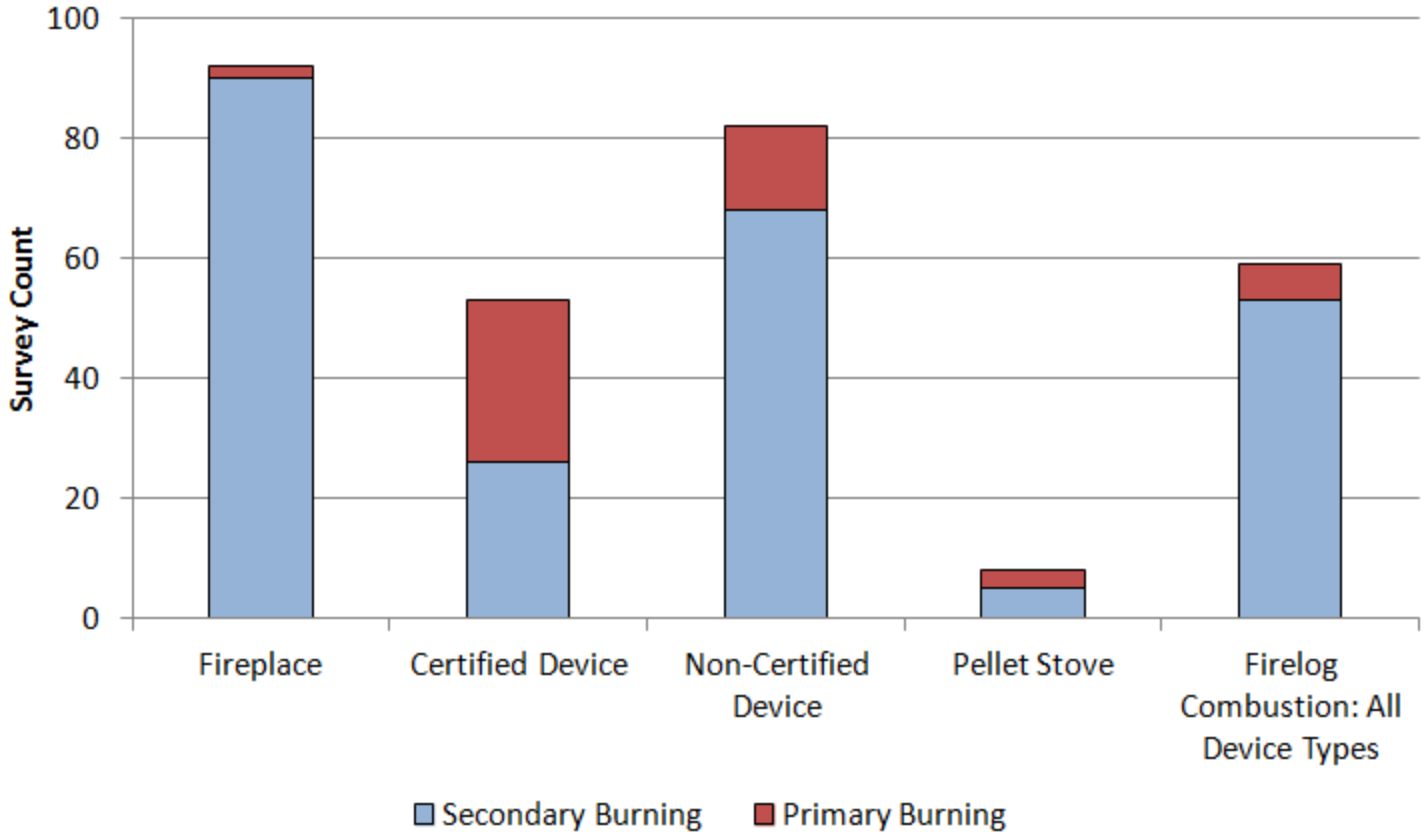
Results: Respondents & Devices



Survey count: Non-burners vs. burners

Results: Respondents & Devices



Survey count: Devices used for primary and secondary burning

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Results: Amount of wood fuel burned

Equation (1) A = (a) x (b) x (c) x (d)

where

A = activity, tons wood burned

a = percent wood burning housing units, by device: from survey results

b = 2013 occupied housing unit data, from the US Census and Portland State University Population Research Center

c = average volume of wood burned in cords, by device: from survey results

d = typical cord density in tons per cord: from survey results for species and type of wood burned

- *Equation applied separately to primary and secondary burning survey results*
- *similar equation for pellets and firelogs, but no need to convert volume to mass*
  - *1 bag of pellets = 40 lbs*
  - *1 firelog = 8 lbs*

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Results: Amount of wood fuel burned

Example:

- Device type = fireplace
- Burning type = secondary burning
- Wood fuel = cordwood

(a) = percent wood burning HU = 8.48%
(b) = occupied HU within survey area in 2013 = 655,613
(c) = avg. volume of wood burned in last 12 months = 0.546 cord
(d) = typical cord density based on wood species burned = 2,637 lbs

(8.48%) x (655,613) x (0.546) x (2,637 lbs) = ***39,890 tons per year***

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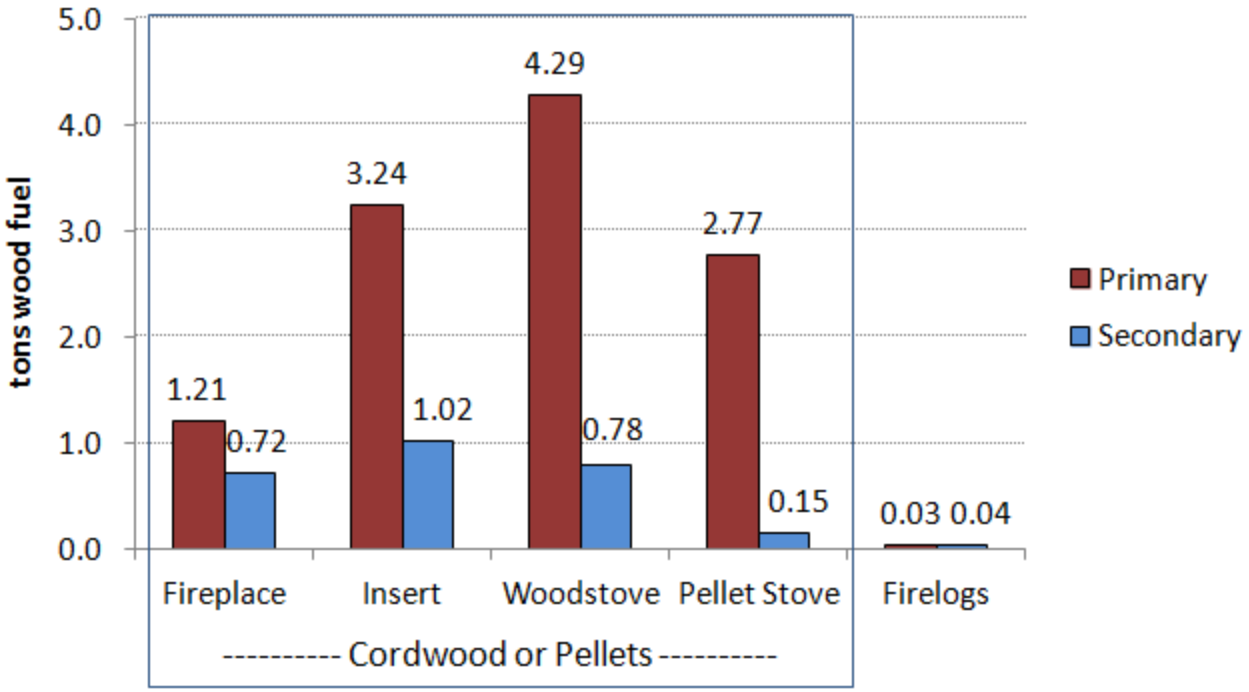
Results: Fuel burned annually by device



Average mass of wood fuel burned annually by device

Based on
- volume cordwood
- species and type wood burned (provides cord density)
- number of bags of pellets burned (1 bag of pellets = 40 lbs)
- number of firelogs burned (1 firelog = 8 lbs)

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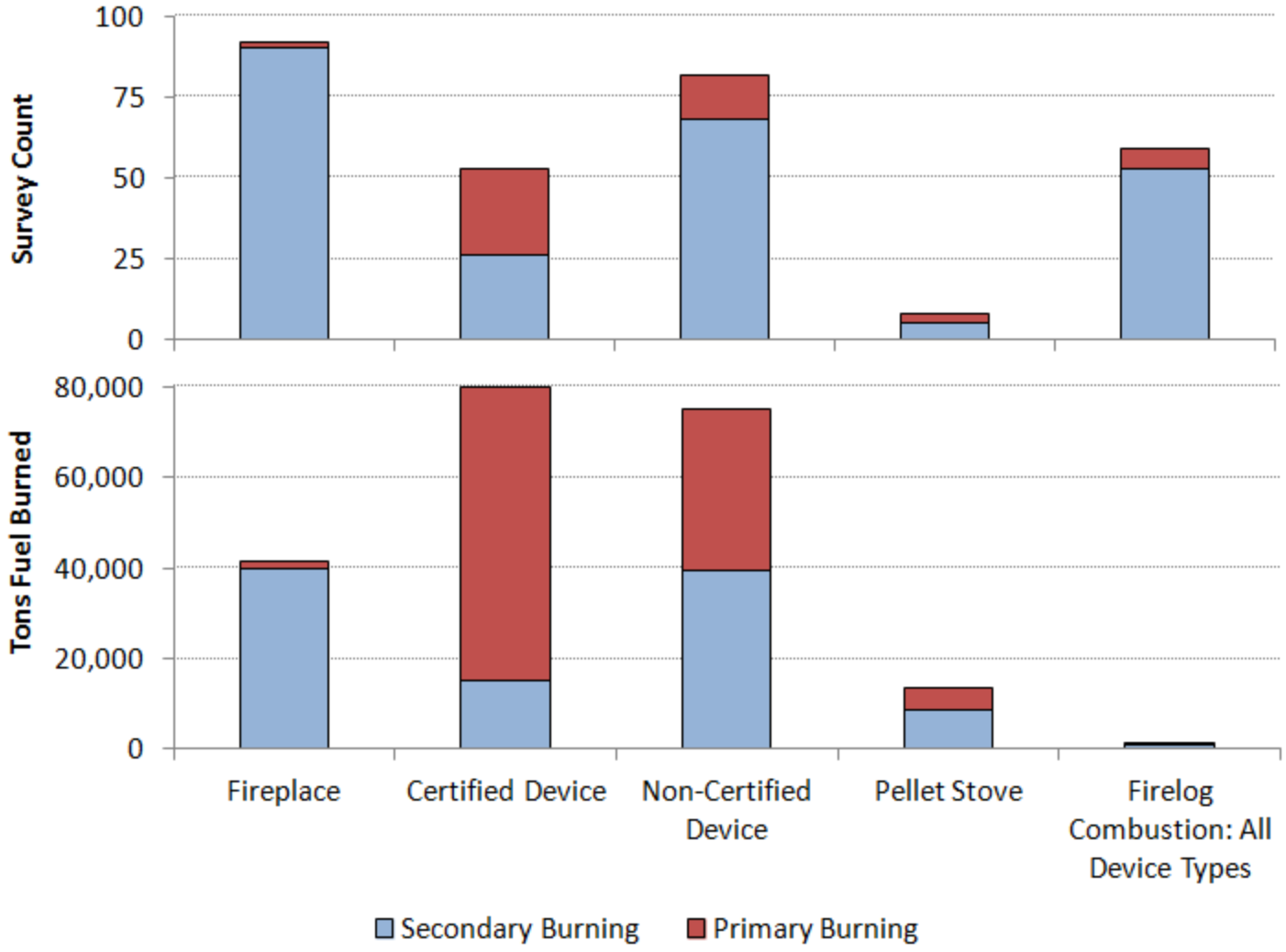
Results: Survey Count vs. Tons Fuel Burned



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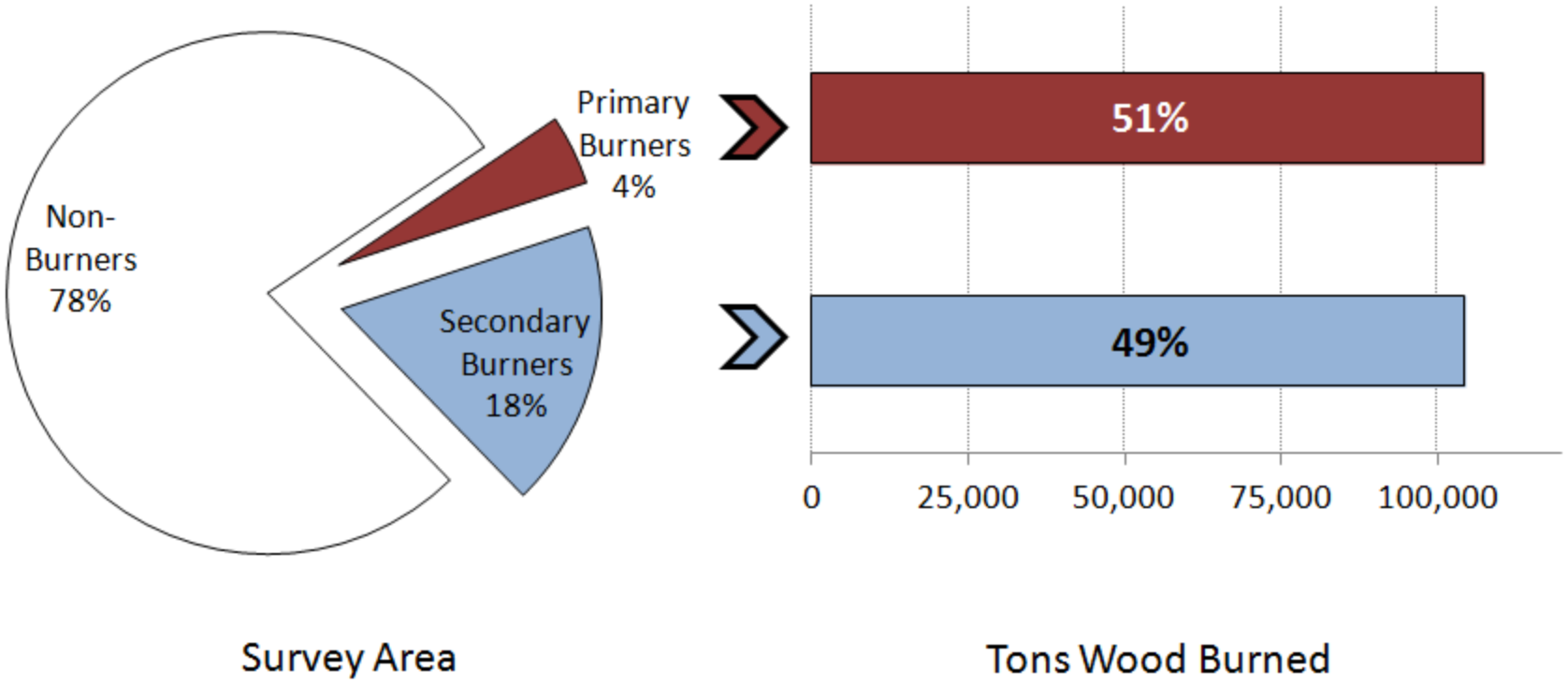
Results: Wood fuel burned



Results: Emissions Estimates

Equation (2) $E = A \times EF / (2000\ lb/ton)$

where

E = Emissions, tons per year

A = Activity in tons wood fuel burned per year

EF = Device Specific Emission Factor in lbs/ton fuel burned

Emission Factor = rate at which pollutant is emitted when wood fuel is combusted =

Device	$PM_{2.5}$ Emission Factor (lb/ton fuel burned)	Reference
Non-Certified Inserts & Woodstoves	30.6	(a)
Firelog Combustion: All Device Types	28.4	(b)
Fireplace	23.6	(a)
Certified Catalytic Inserts & Woodstoves	20.4	(a)
Certified Non-Catalytic Inserts & Woodstoves	19.6	(a)
Pellet Stove	3.06	(c)

(a) US EPA. Documentation For The 2002 Base Year National Emission Inventory For Hazardous Air Pollutants: Appendix A

(b) Li, Victor S., and Rosenthal, Steven. "Content and emissions characteristics of Artificial Wax Firelogs." Paper presented at the 15th International Emission Inventory Conference. New Orleans, Lousiana. May 15th-18th, 2006

(c) Houck, James E., Eagle, Brian N. Control Analysis and Documentation for Residential Wood Combustion in the MANE-VU Region. Prepared for MARAMA. December 19, 2006.

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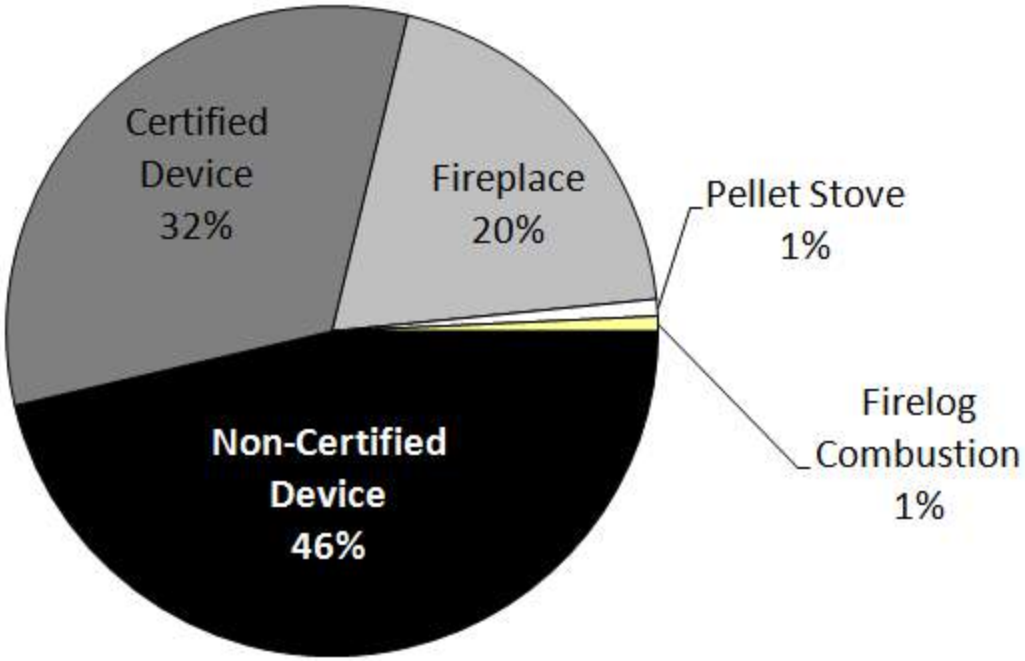
Results: Emissions Estimates



$PM_{2.5}$ emissions estimates in tons per year by device type

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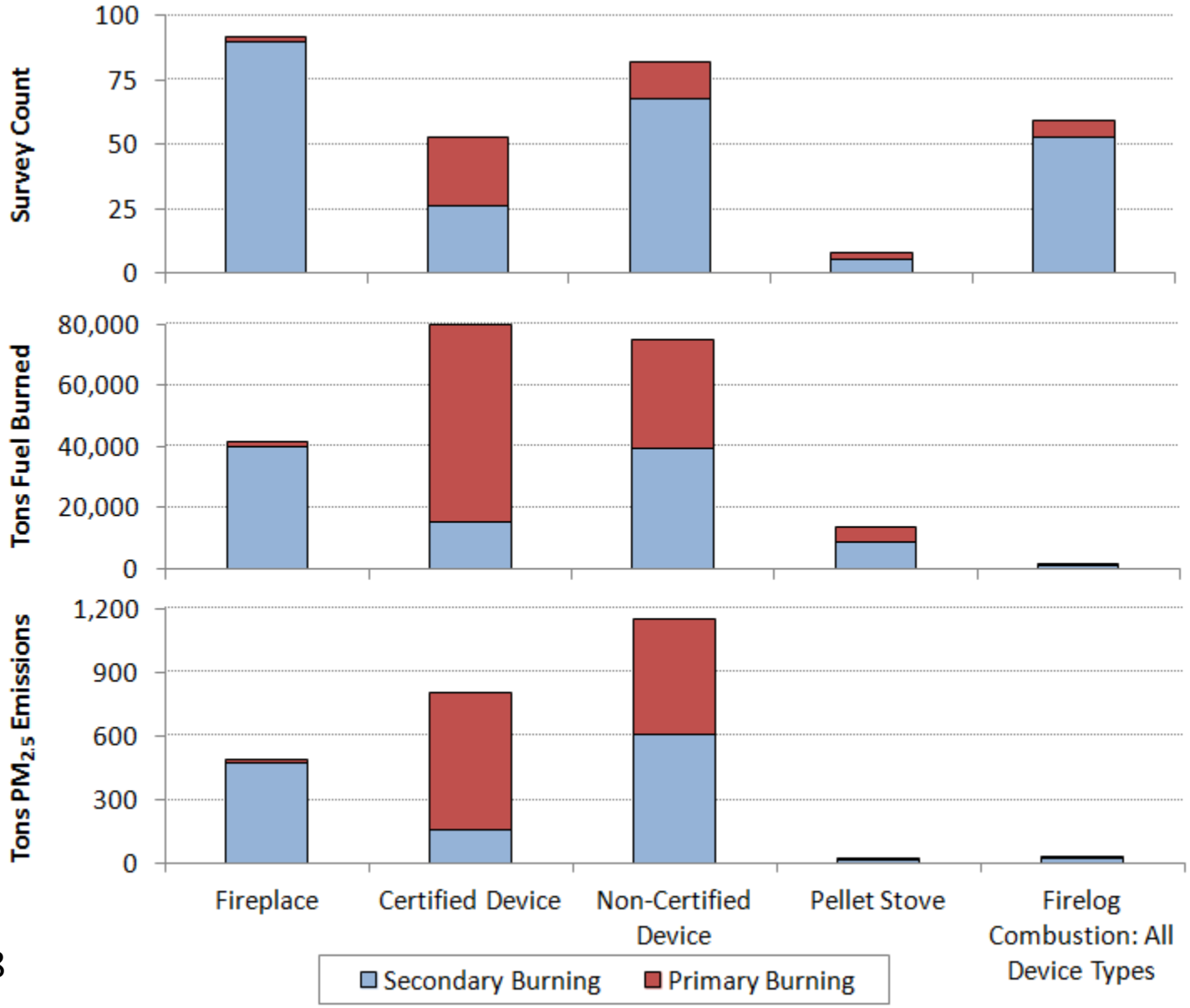
Results: count vs. activity vs. emissions



Total survey count 294

Total tons fuel burned 211,561

Total tons $PM_{2.5}$ emissions 2,482

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Spatial Allocation of Emissions: Allocation of emissions to block-group

- Survey results for burning activity and housing type showed a good correlation

- Survey results by sub-area were mapped to Census housing data for block groups in that sub-area using housing type

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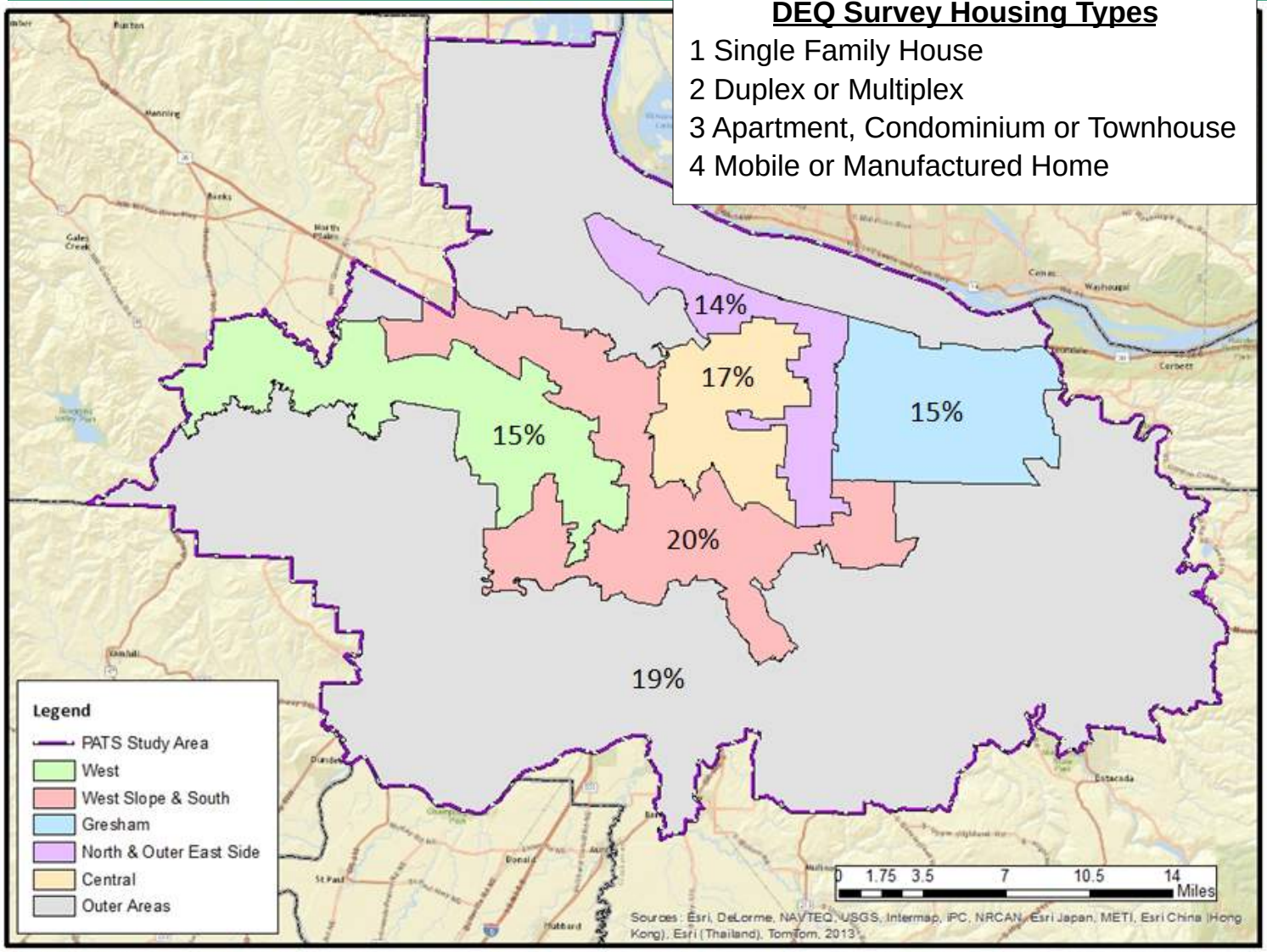
Survey design: sub-areas



Sub-areas delineated by DEQ staff using local knowledge of demographics

Percentages represent the sub-area percent of the total occupied housing units (HU) within the study area

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Mapping DEQ Residential Wood Heating Household to Census Households

Sub Area	Build Type	Description	Non Burner	Primary Burner	Primary + Secondary	Secondary Burner	FP Burner	Insert Burner	Woodstove Burner	Fire Log	Pellet Burner	Primary Total	Secondary Total	# Survey Calls	NoBurn %	Primary %	Secondary %
1	Total 1+2	Single/multplex	128	3	1	26	13	11	3	8	1	4	26	156	82.1%	2.6%	16.7%
1	Total 3-4	Apt/Condo	18	0	0	1	1	0	0	0	0	0	1	19	94.7%	0.0%	5.3%
1	Total All		146	3	1	27	14	11	3	8	1	4	27	175	83.4%	2.3%	15.4%
2	Total 1+2	Single/multplex	118	5	1	37	19	15	9	9	0	6	39	159	74.2%	3.8%	24.5%
2	Total 3-4	Apt/Condo	15	0	0	1	1	0	0	1	0	0	1	16	93.8%	0.0%	6.3%
2	Total All		133	5	1	38	20	15	9	10	0	6	40	175	76.0%	3.4%	22.9%
3	Total 1-2	Single/multplex	94	2	1	42	25	6	11	11	1	3	41	137	68.6%	2.2%	29.9%
3	Total 3-4	Apt/Condo	34	0	0	2	2	0	0	1	0	0	2	36	94.4%	0.0%	5.6%
3	Total All		128	2	1	44	27	6	11	12	1	3	43	173	74.0%	1.7%	24.9%
4	Total 1-2	Single/multplex	135	4	0	22	10	9	8	13	0	4	24	161	83.9%	2.5%	14.9%
4	Total 3-4	Apt/Condo	13	1	0	0	0	0	1	1	0	1	0	14	92.9%	7.1%	0.0%
4	Total All		148	5	0	22	10	9	9	14	0	5	24	175	84.6%	2.9%	13.7%
5	Total 1-2	Single/multplex	125	6	0	22	7	9	8	5	1	6	20	153	81.7%	3.9%	13.1%
5	Total 3-4	Apt/Condo	22	0	0	1	0	0	0	1	0	0	0	23	95.7%	0.0%	0.0%
5	Total All		147	6	0	23	7	9	8	6	1	6	20	176	83.5%	3.4%	11.4%
6	Total 1-2	Single/multplex	124	21	1	28	12	9	24	8	5	26	27	172	72.1%	15.1%	15.7%
6	Total 3-4	Apt/Condo	11	1	0	3	0	0	4	1	0	1	3	15	73.3%	6.7%	20.0%
6	Total All		135	22	1	31	12	9	28	9	5	27	30	187	72.2%	14.4%	16.0%
	Total All 1-2	Single/multplex	724	41	4	177	86	59	63	54	8	49	177	938	77.2%	5.2%	18.9%
	Total All 3-4	Apt/Condo	113	2	0	8	4	0	5	5	0	2	7	123	91.9%	1.6%	5.7%
	Total All All		837	43	4	185	90	59	68	59	8	51	184	1061	78.9%	4.8%	17.3%

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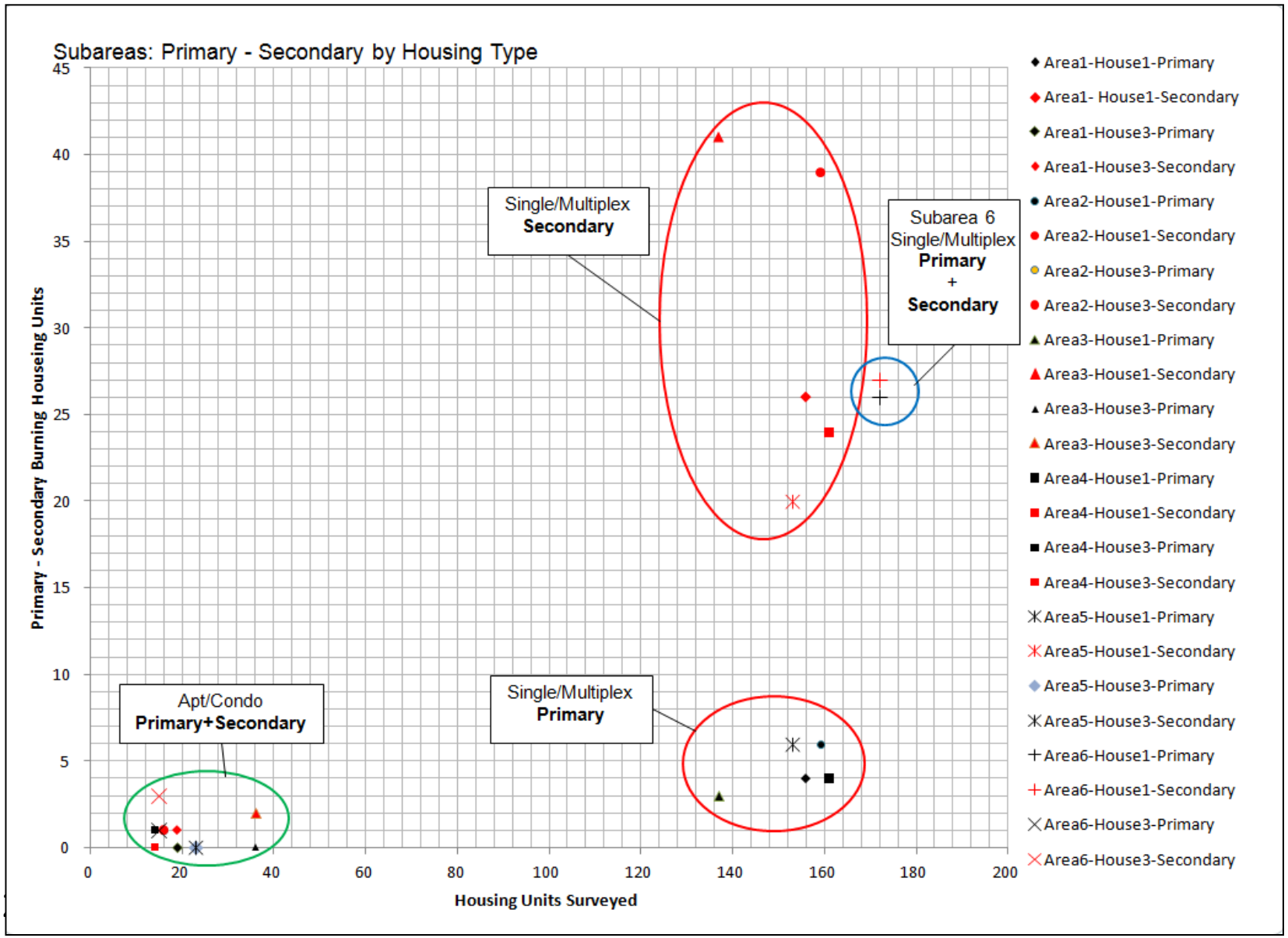
DEQ Residential Wood Heating and Households



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Mapping DEQ Residential Wood Heating Household to Census Households

DEQ Survey Housing Types

1 Single Family House
2 Duplex or Multiplex

3 Apartment, Condominium/Townhouse
4 Mobile or Manufactured Home

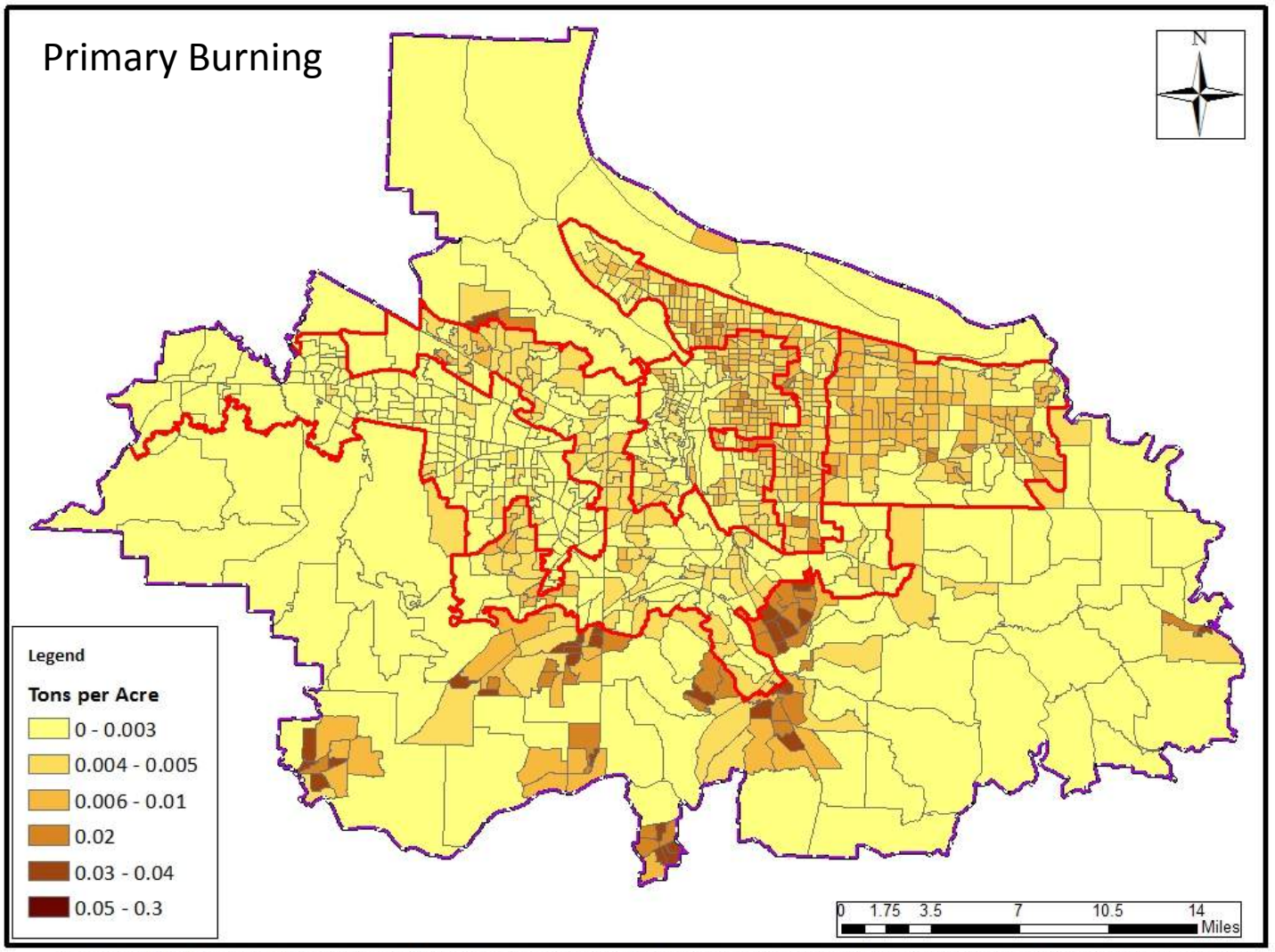
US Census Housing Types by Block Group

B25024_1 detached
B25024_1 attached
B25024_2B25024_3 or 4
B25024_5 to 9

B25024_10 to 19
B25024_20 to 49
B25024_50 or more
B25024_Mobile home
B25024_Boat, RV, van, etc#

DEQ Survey of 1061 Households		US Census Block Groups	
88.4%	Single/multiplex	81.5%	detached to 9 units
11.6%	Apt/Condo	18.5%	> 9 units
100.0%		100.0%	

Spatial Allocation of Emissions: Maps



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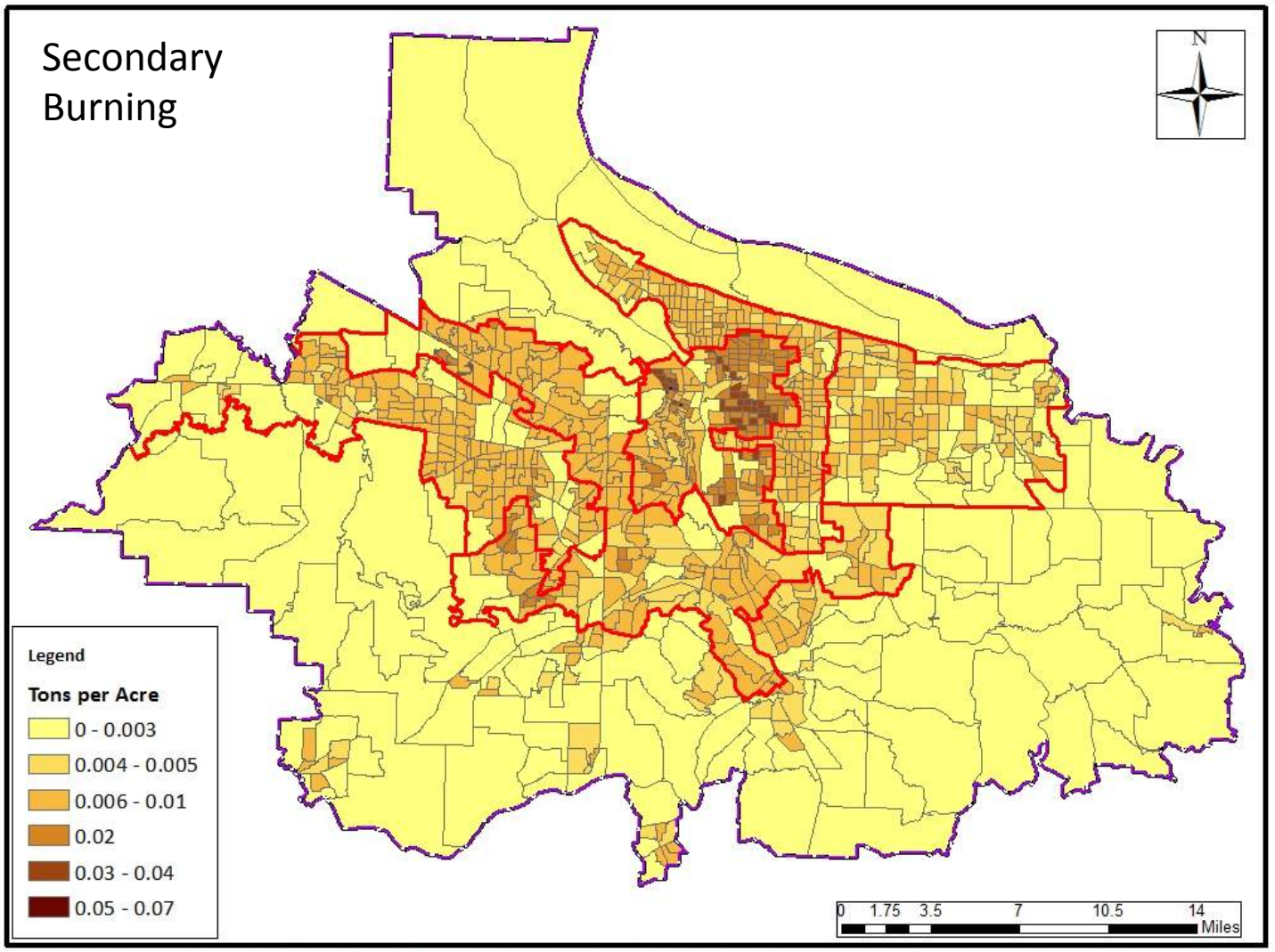

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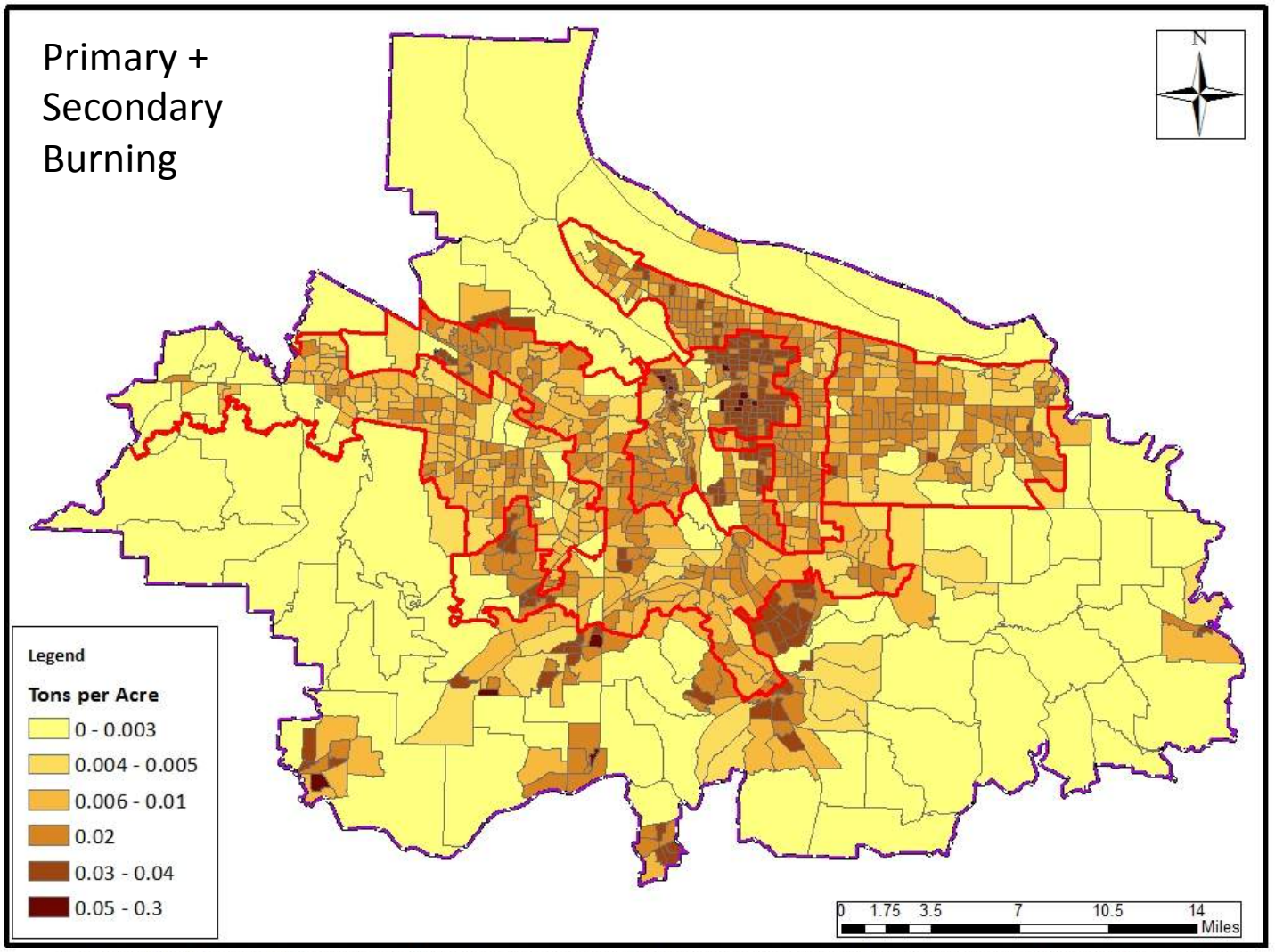
Spatial Allocation of Emissions: Maps



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Conclusions

- Total burning is equal parts primary and secondary burning
- Fewer primary burners that burn more wood per device on avg
- More secondary burners that burn less wood per device on avg
- PM2.5 emissions breakdown is roughly
  - 46 % from non-certified devices
  - 32% from certified devices
  - 20% from fireplaces
  - 2% from pellet stove and firelog combustion
- Survey data mapped to US Census data results in most primary burners allocated to rural areas, and most secondary burners allocated to urban and suburban areas, including NE Portland

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Take-away:

- An accurate inventory distributed in an area with diverse wood use and demographics
- Identify specific areas with high emissions for reduction strategies
- Provide information for change-out programs
- Most accurate Oregon RWC survey yet for primary vs. secondary burning matched back to demographics
- Data analysis not complete:

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Questions?

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