Oregon DEQ AQ-Technical Services

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

April 15, 2015

EPA 2015 International Emission Inventory Conference

San Diego, CA

Christopher Swab | Oregon Department of Environmental Quality

DEQ
State of Oregon
Department of
Environmental
Quality

Overview

- Background:
  - Portland Air Toxics Solution (PATS) Project
  - Need for follow-up survey
- 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

DEQ
State of Oregon
Department of
Environmental
Quality

Portland Air Toxics Solutions (PATS) Project

- Modeling study of air toxics problems and potential solutions in the Portland metro region : http://www.deq.state.or.us/aq/toxics/pats.htm
- *PATS modeling of concentrations from residential wood combustion emissions was dependent upon a 2009 statewide RWC survey in which regional results were allocated to the Portland region using US Census data at the block group level.*

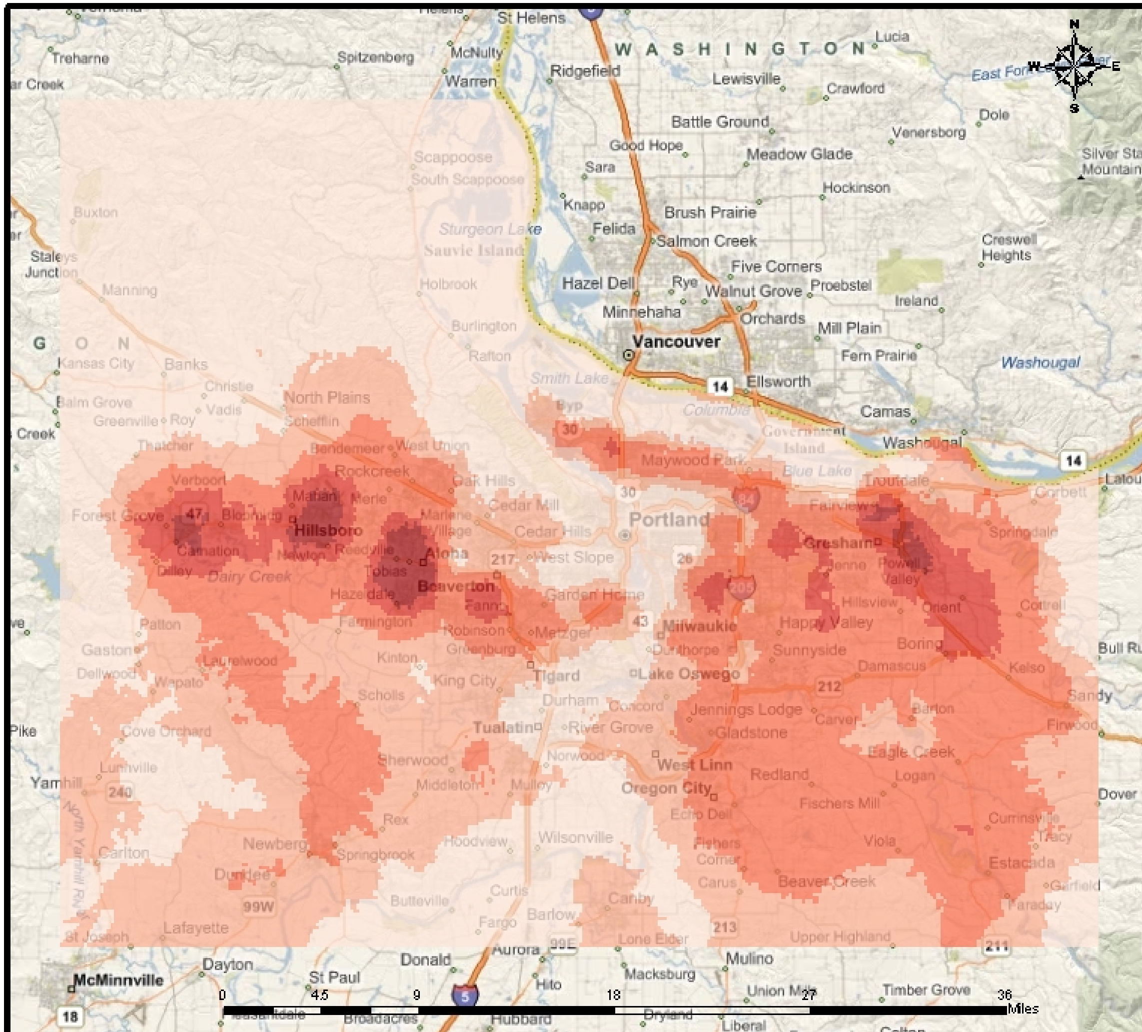
Pollutant	Top Source	Impact Area
More than 10 times over benchmark		
1,3 butadiene	Cars and trucks	Region wide/neighborhood
Benzene	Cars and trucks	Region wide/neighborhood
Diesel Particulate	Cars and trucks	Region wide/neighborhood
15 PAH	Residential wood burning	Region wide
Naphthalene	Residential wood burning	Region wide/neighborhood
Cadmium	Industry	Neighborhood
Formaldehyde	Chemical formation in atmosphere	Region wide
Acrolein	Chemical formation in atmosphere	Region wide/neighborhood

Portland Air Toxics Solutions (PATS) Project

PATS 2017
MODELING RESULTS

Residential Wood
Combustion

State of Oregon
Department of
Environmental
Quality



Date: 04-05-2011 G:\Portland Air Toxics Solutions\Modeling\Concentrations-GIS\Area-Reduction\GIS

Times above ABC

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

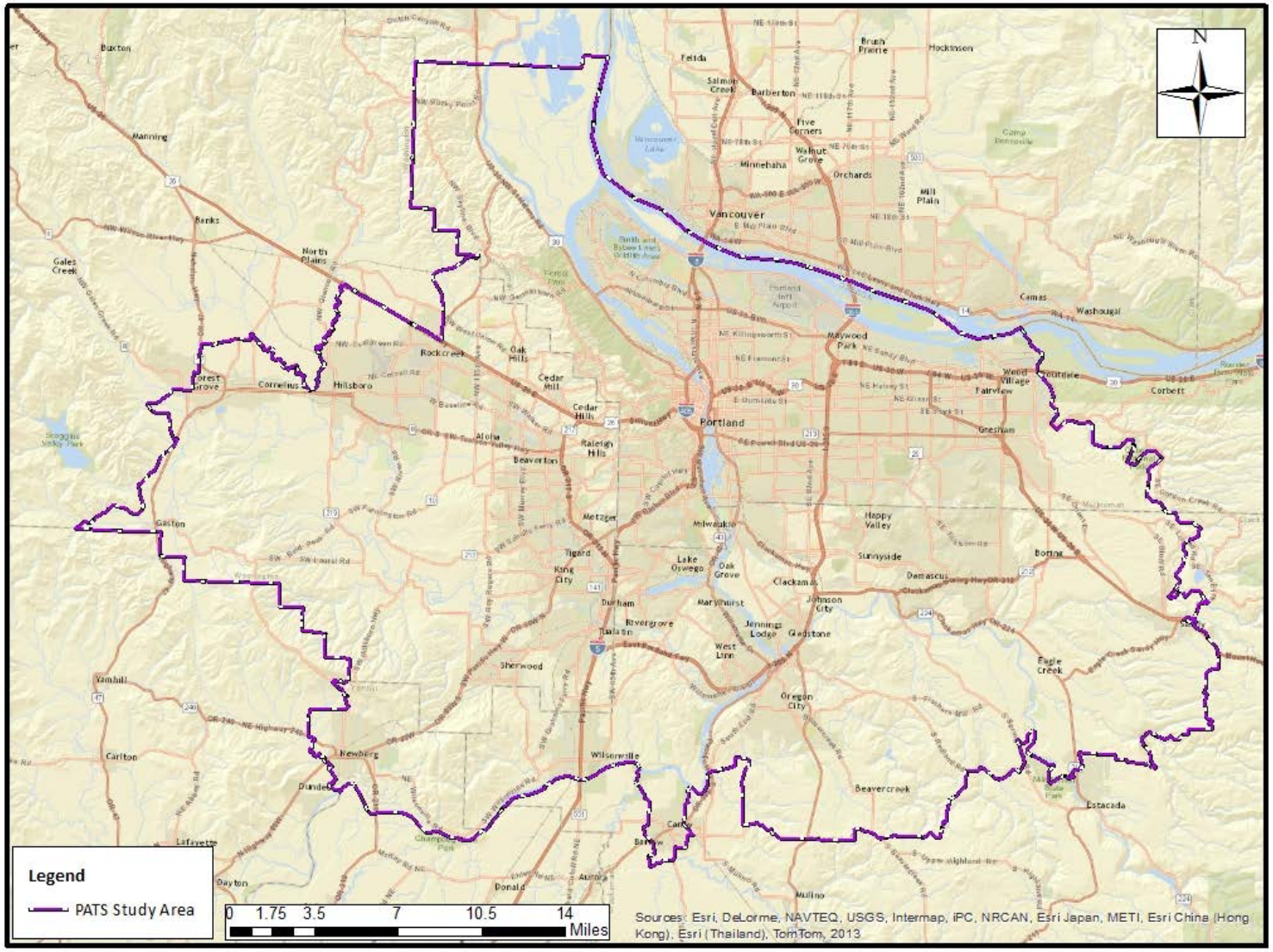
References:
Concentration data from DEQ Portland Air Toxics Solution (PATS) study
Basemaps from Metro and ESRI

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)

State of Oregon
Department of
Environmental
Quality

PATS study area = survey area



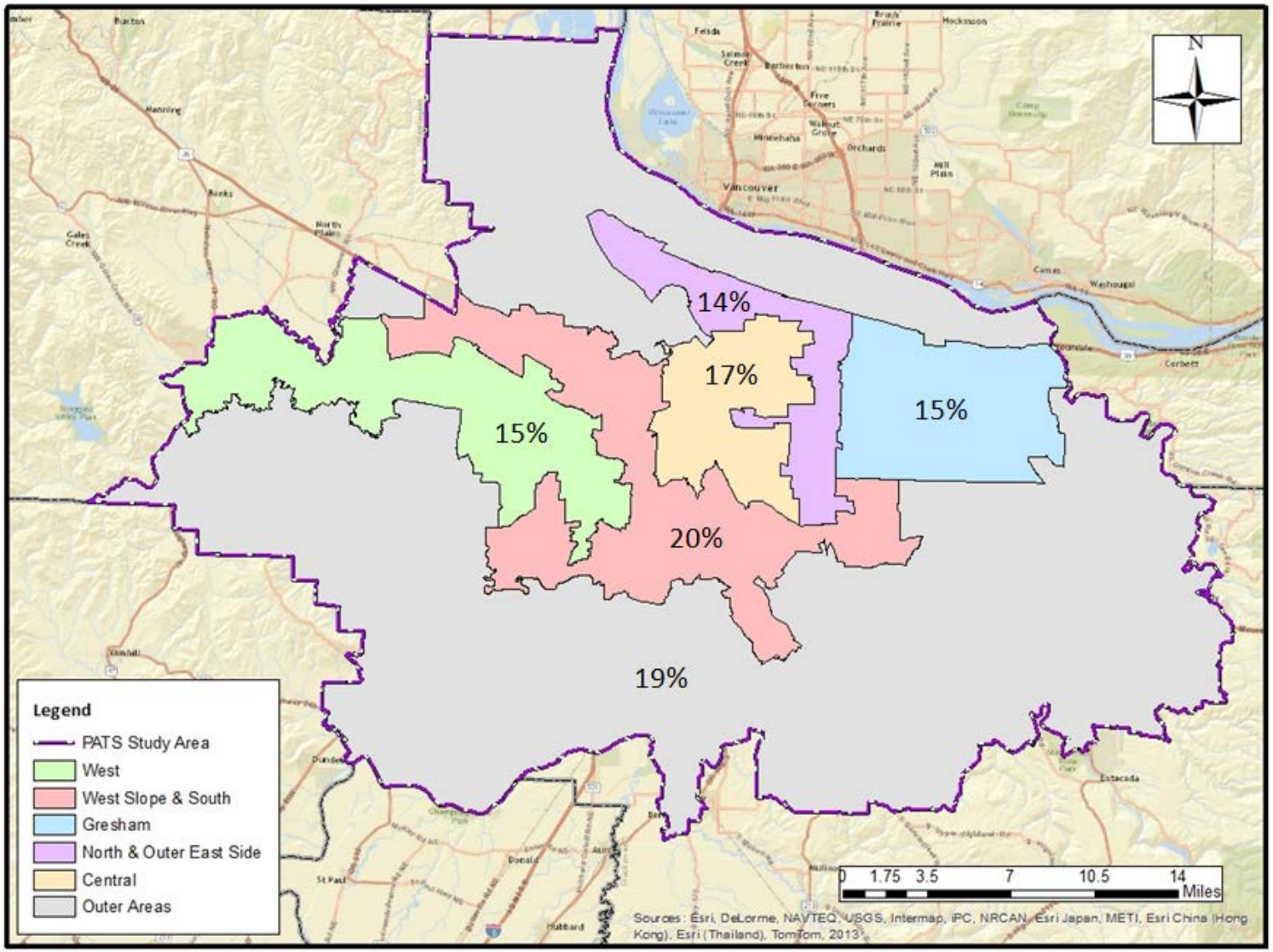
\\deqhq1\EI_FILES\Residential_Wood_Combustion\RWC & Open Burning Surveys\PATS_RWC_Survey\FollowUp_Survey\Emission_Inventory\FINAL_DATA\Final_GIS\PATS_RWC_FollowUpSurvey_Final_GIS_Granular4_paper.mxd
CLS, 3/26/15

DEQ
State of Oregon
Department of Environmental Quality

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
- Questions asked include wood use and demographics

Survey design: sub-areas

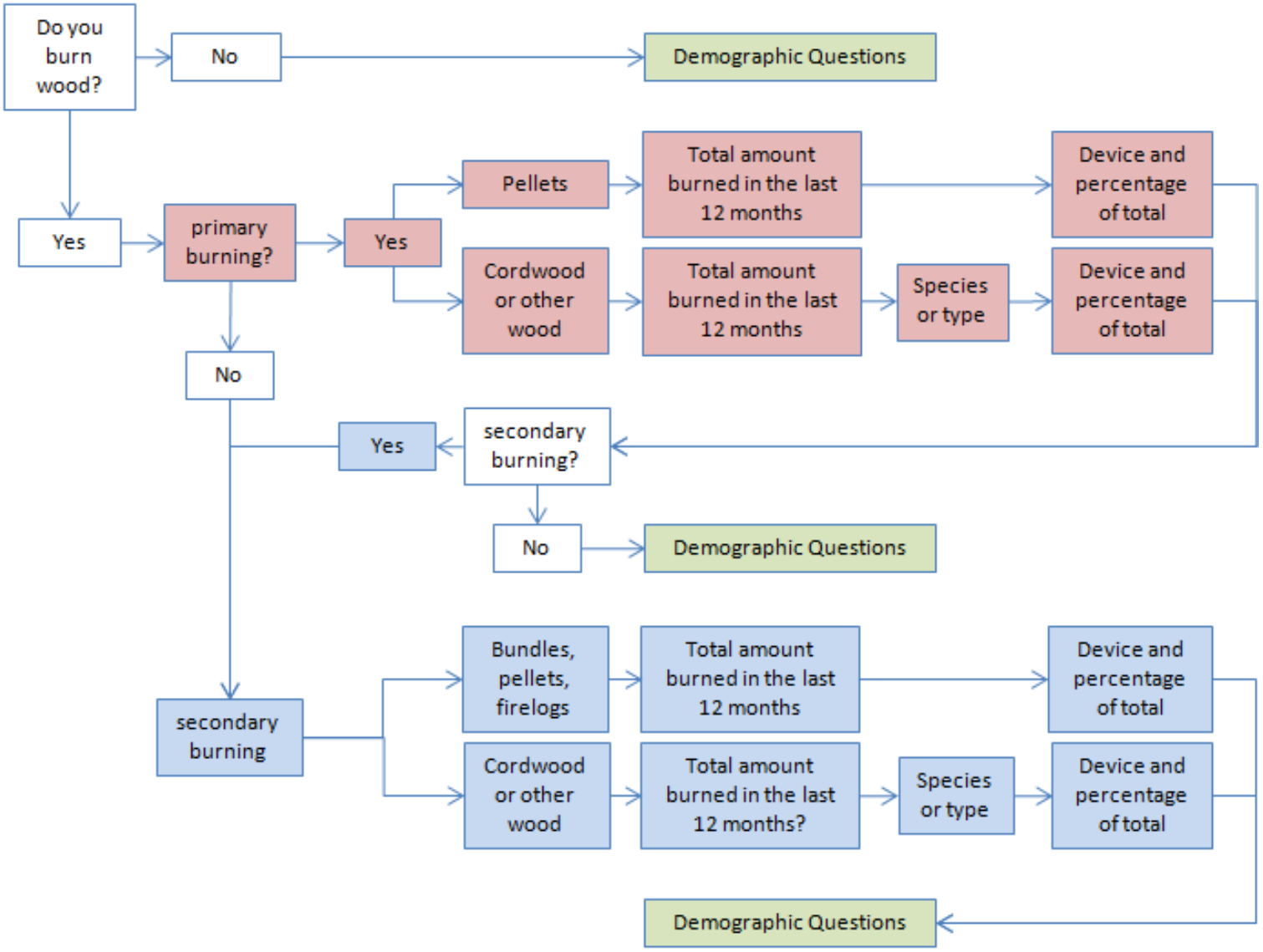


Sub-areas delineated by DEQ staff using local knowledge of demographics

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

DEQ State of Oregon Department of Environmental Quality

Survey Instrument: Simplified flow-chart



DEQ
State of Oregon
Department of Environmental Quality

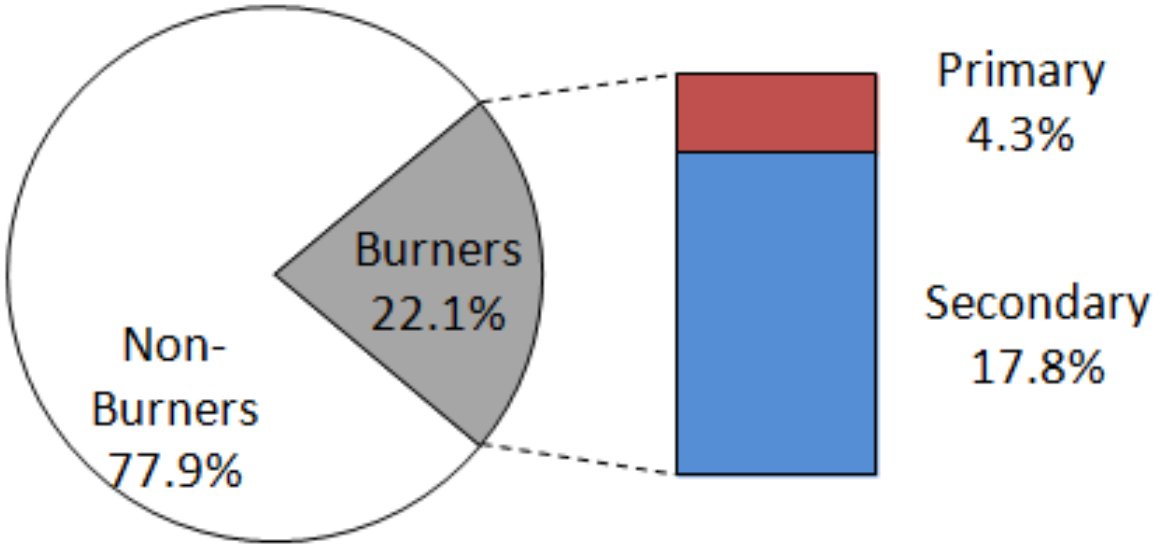
Number of completed surveys

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

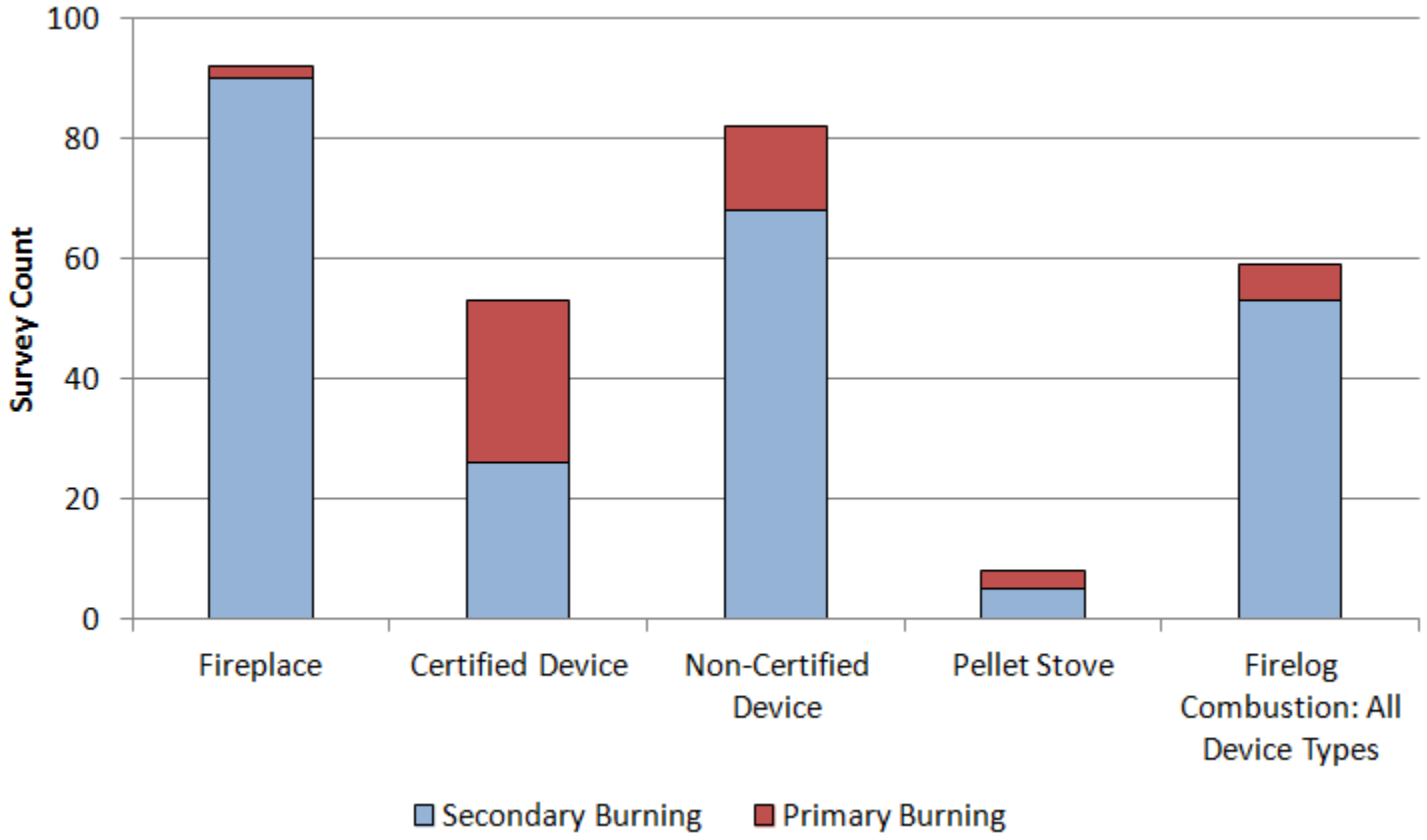
DEQ
State of Oregon
Department of
Environmental
Quality

Results: Respondents & Devices



Survey count: Non-burners vs. burners

Results: Respondents & Devices



Survey count: Devices used for primary and secondary burning

DEQ State of Oregon Department of Environmental Quality

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*

Results: Amount of wood fuel burned

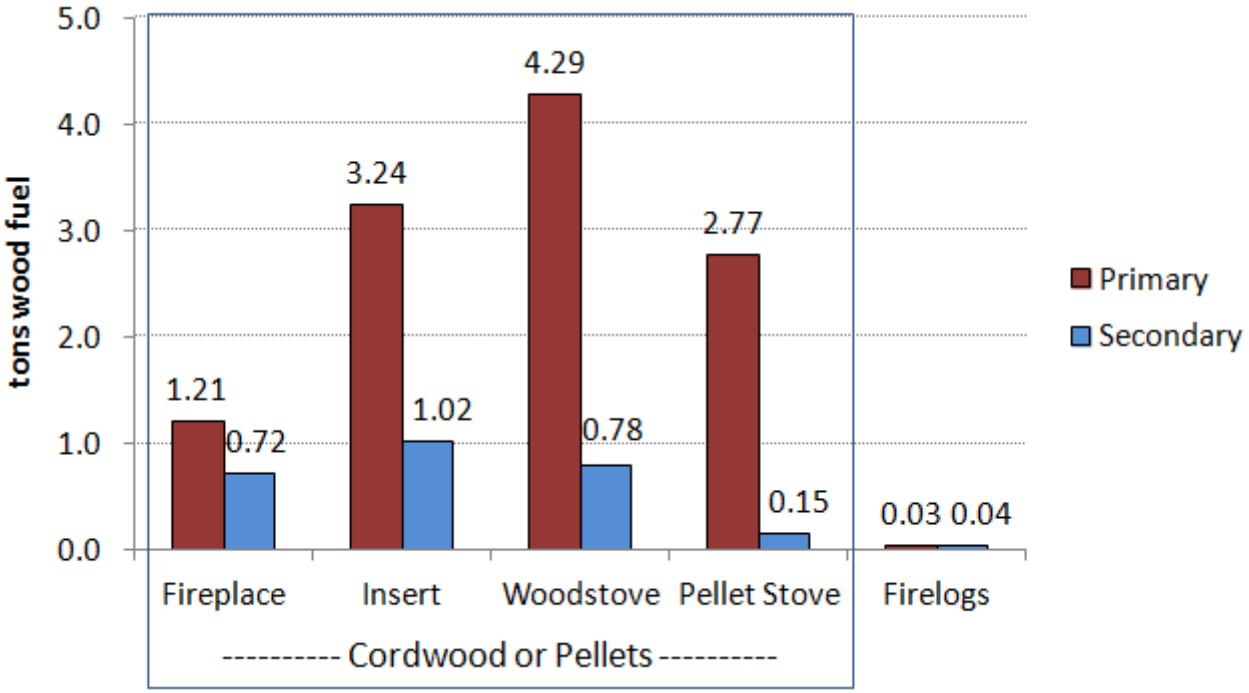
Example:

- 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***

Results: Fuel burned annually by device

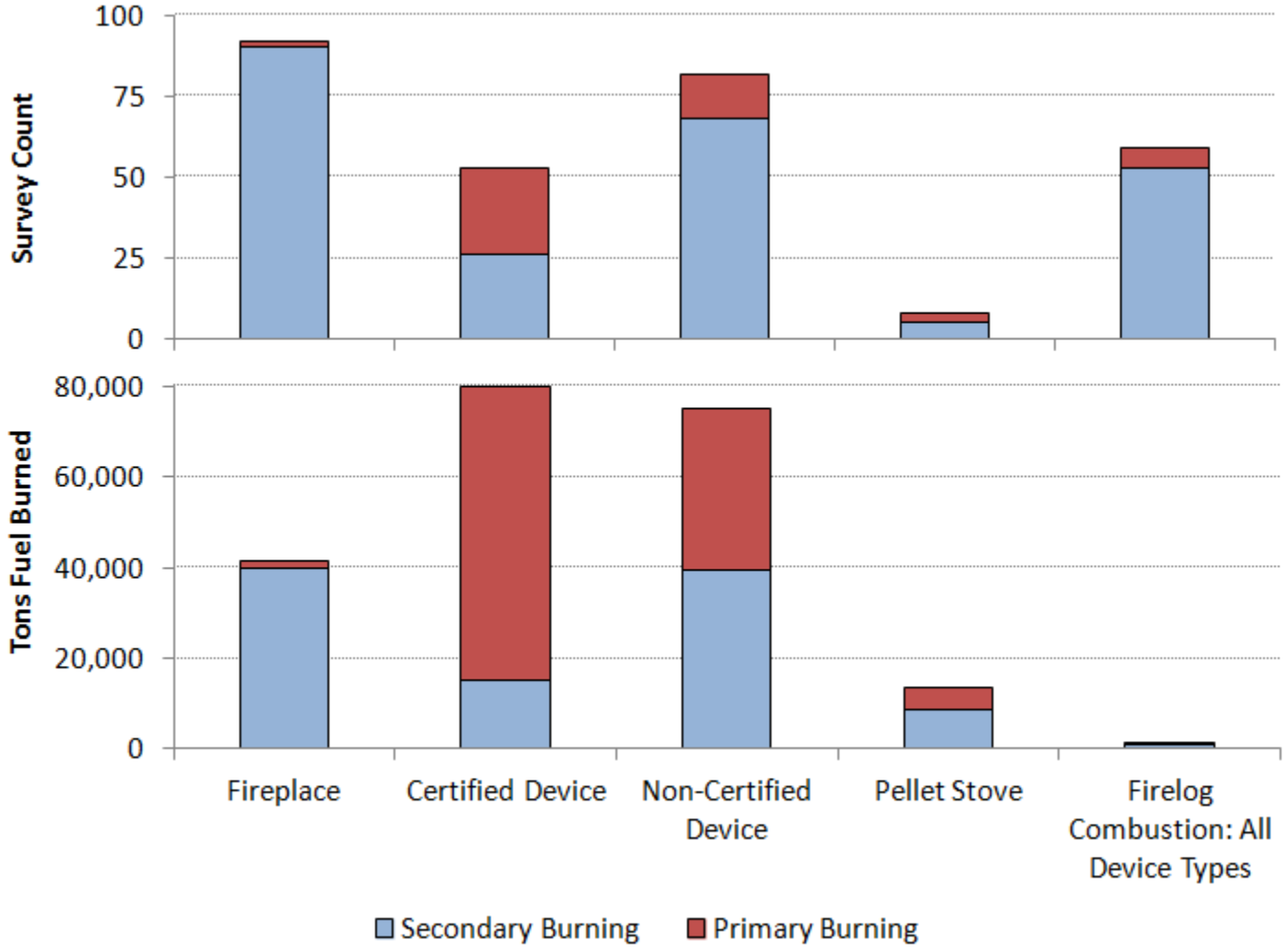


Average mass of wood fuel burned annually by device

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)

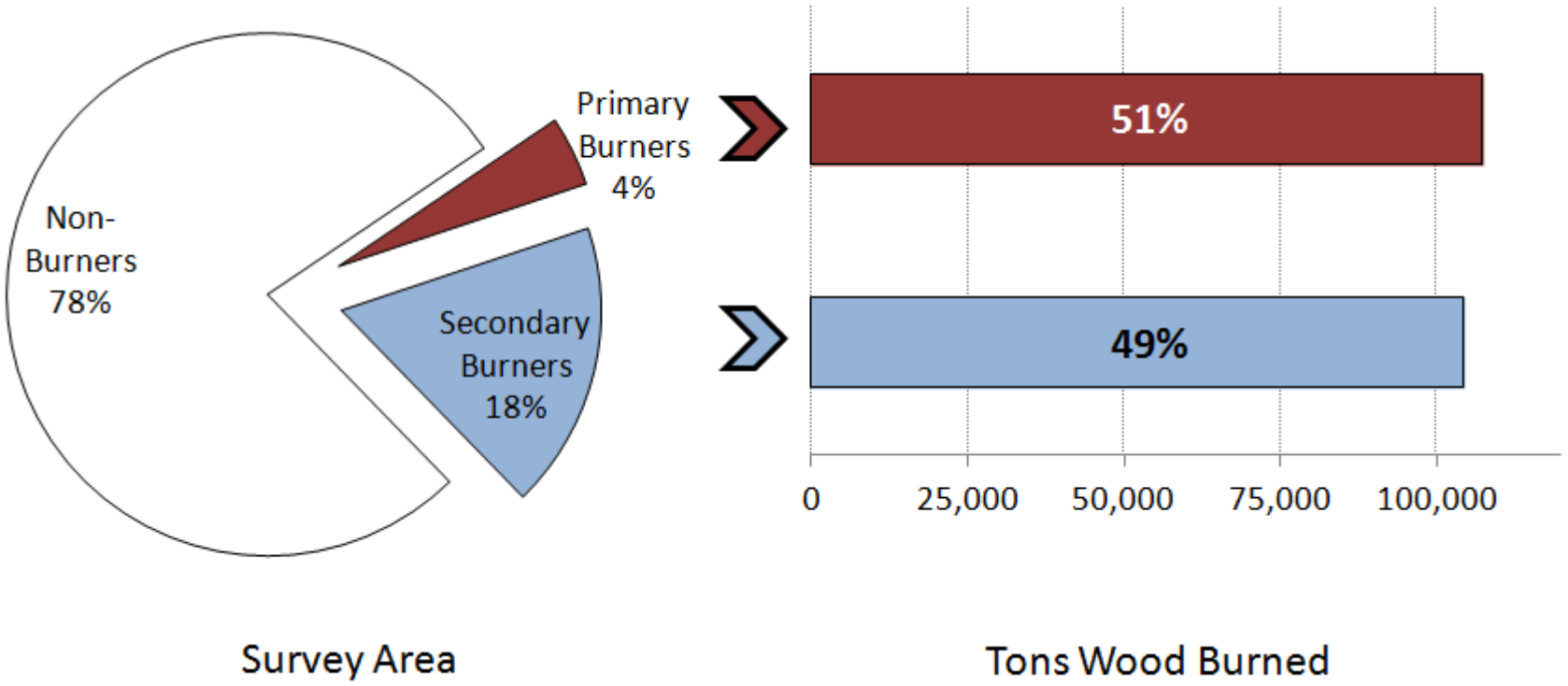
DEQ State of Oregon Department of Environmental Quality

Results: Survey Count vs. Tons Fuel Burned



DEQ
State of Oregon Department of Environmental Quality

Results: Wood fuel burned



DEQ State of Oregon Department of Environmental Quality

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 =

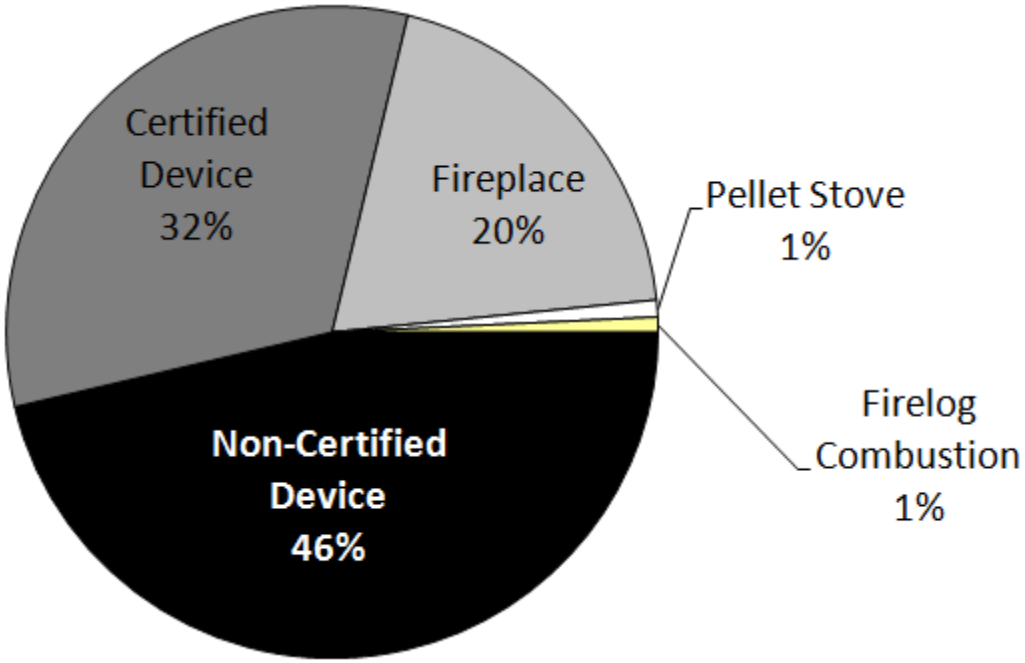
Device	$PM_{2.5}$ Emission Factor (lb/ton fuel burned)	Reference
Non-Certified Inserts & Woodstoves	30.6	(a)
Firelog Combustion: All Device Types	28.4	(b)
Fireplace	23.6	(a)
Certified Catalytic Inserts & Woodstoves	20.4	(a)
Certified Non-Catalytic Inserts & Woodstoves	19.6	(a)
Pellet Stove	3.06	(c)

(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

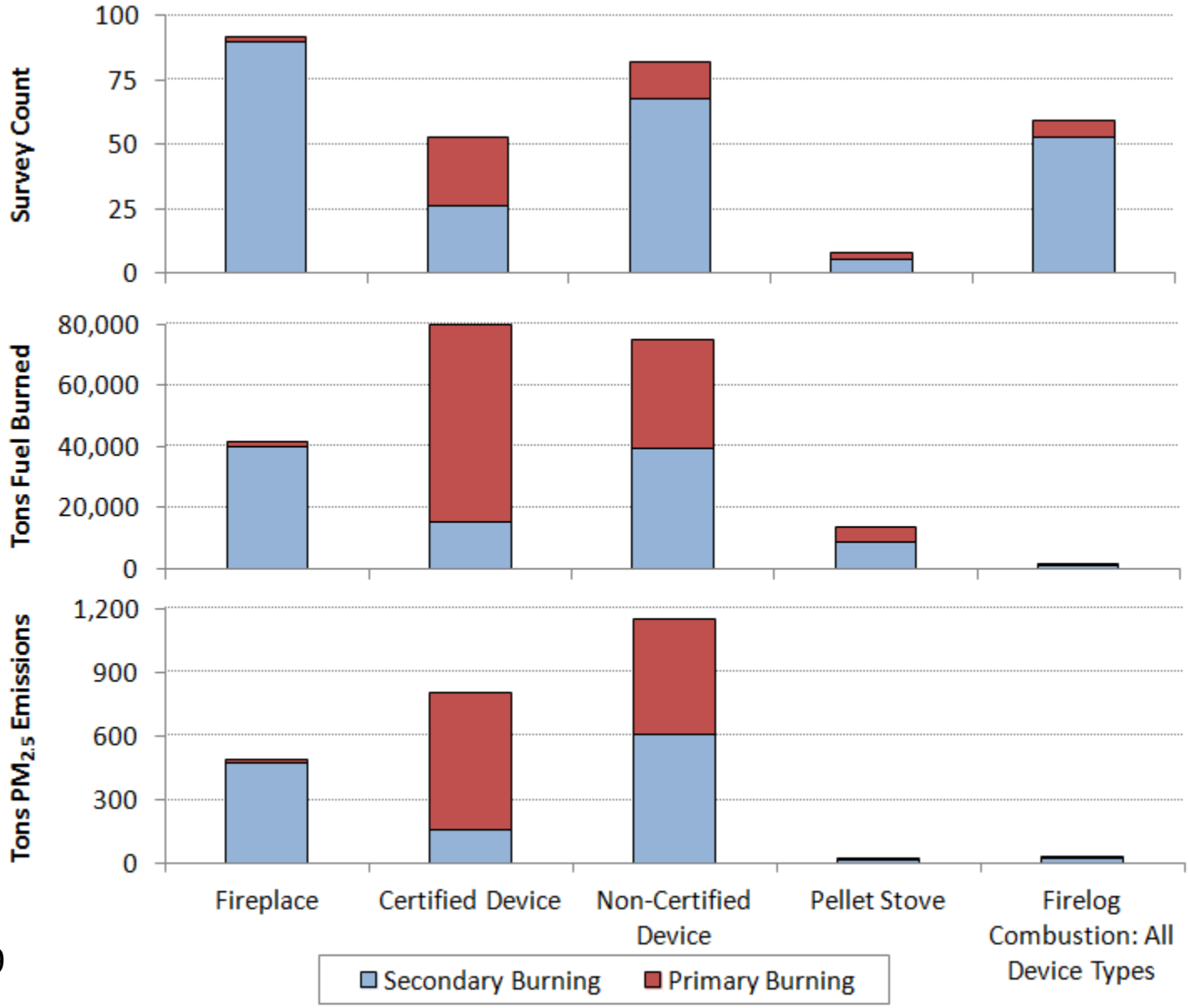
(c) Houck, James E., Eagle, Brian N. Control Analysis and Documentation for Residential Wood Combustion in the MANE-VU Region. Prepared for MARAMA. December 19, 2006.

Results: Emissions Estimates



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

Results: count vs. activity vs. emissions



Total survey count 294

Total tons fuel burned 211,561

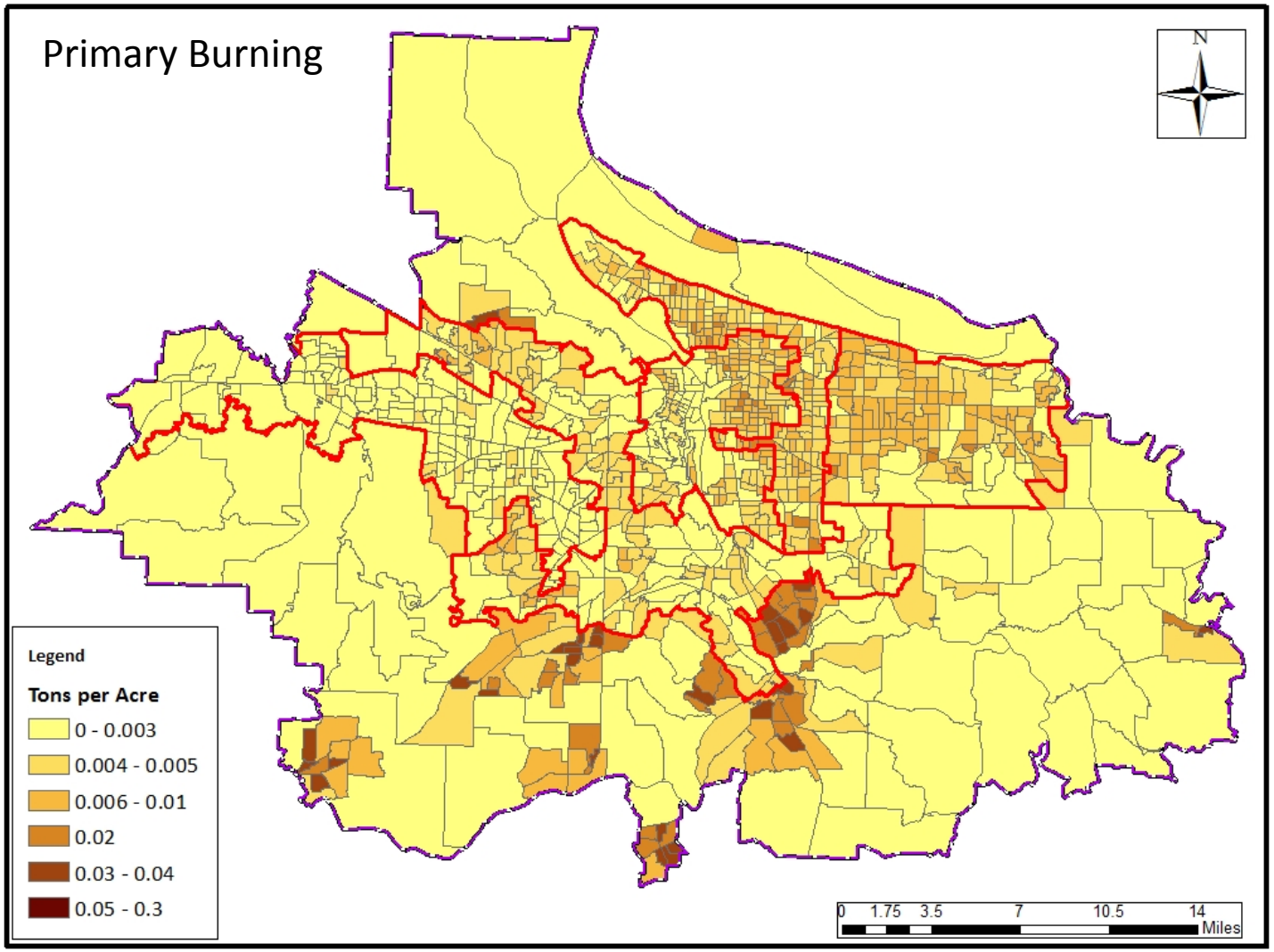
Total tons $PM_{2.5}$ emissions 2,482

DEQ State of Oregon Department of Environmental Quality

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

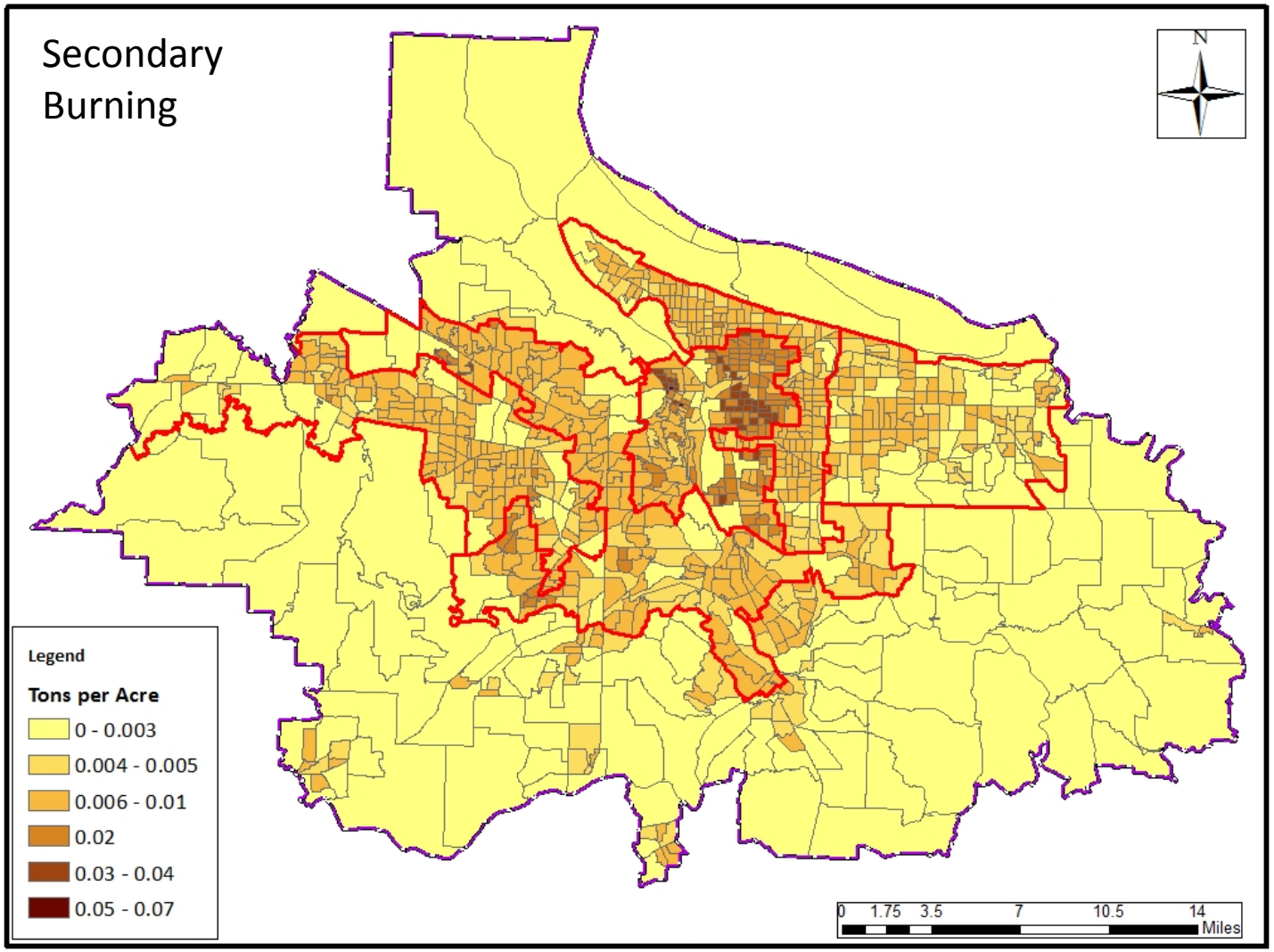
- Survey results for burning activity and housing type showed a good correlation
- Survey results by sub-area were mapped to Census housing data for block groups in that sub-area using housing type

Spatial Allocation of Emissions: Maps



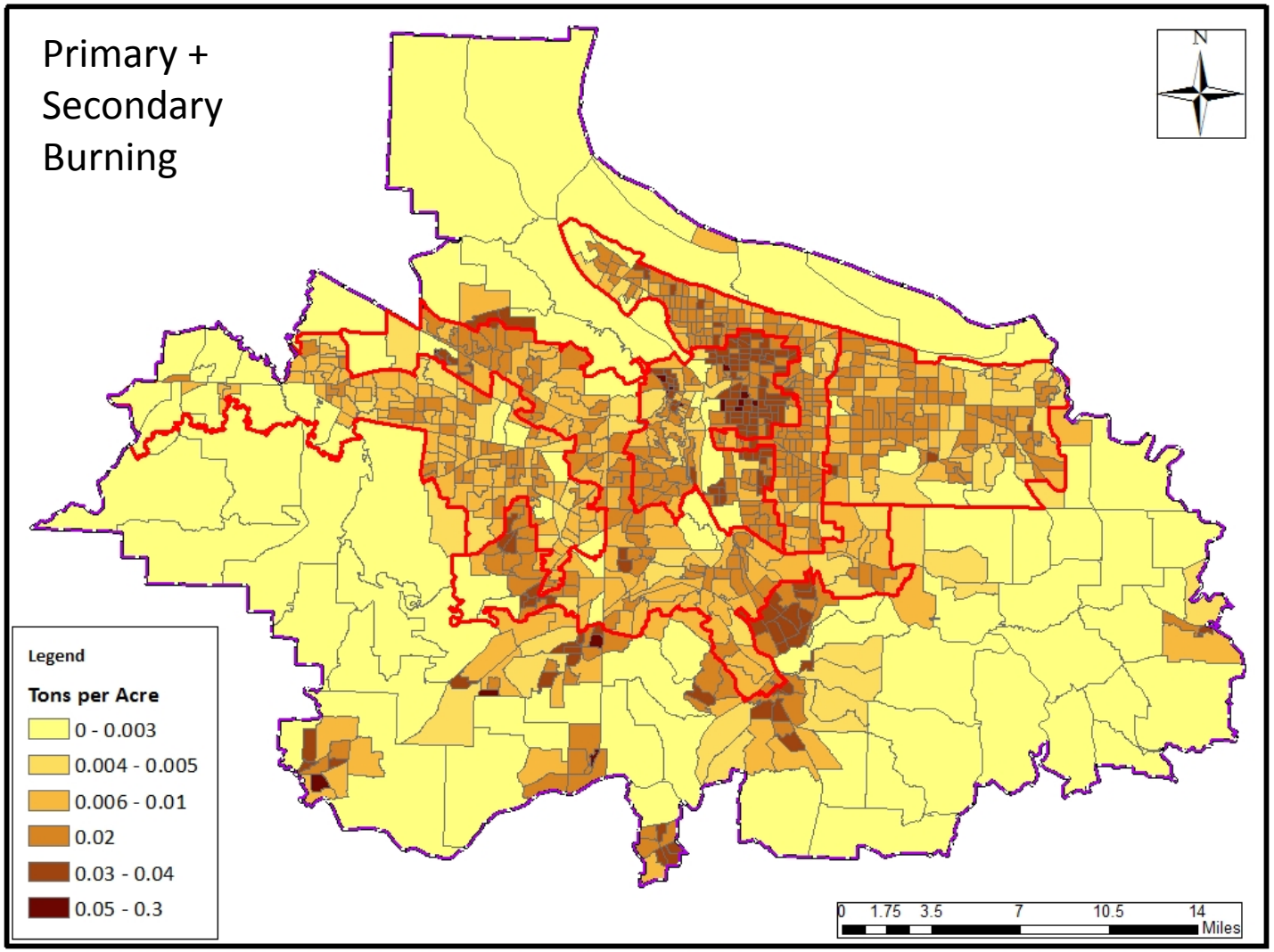
DEQ State of Oregon Department of Environmental Quality

Spatial Allocation of Emissions: Maps



DEQ State of Oregon Department of Environmental Quality

Spatial Allocation of Emissions: Maps



DEQ State of Oregon Department of Environmental Quality

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

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

Questions?

Contact:

Christopher Swab
swab.christopher@deq.state.or.us