

WOOD SMOKE

Understanding the Wood Stove Problem

**Protecting Environmental and Human Health Through
Partnership and Communities**

Tuesday February 23, 2010

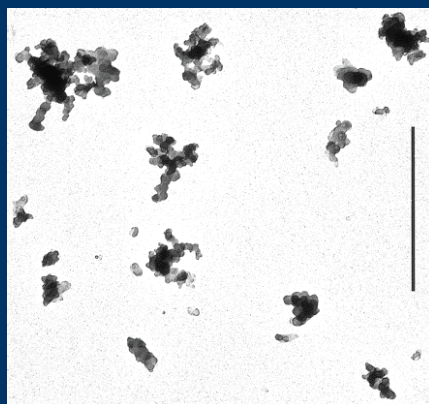
Eleanor Setton

Adjunct Assistant Professor
University of Victoria – Spatial Sciences Research Lab

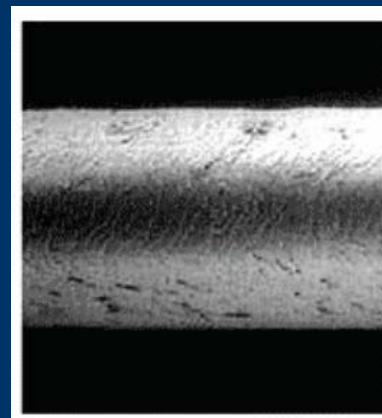
elsetton@uvic.ca



Wood smoke produces fine particles (< 2.5 microns)



1 μm
1/1000 mm



60 μm

Adapted from: Leckie S et al (2008)
Evaluating the Air Quality and Health
Impacts of a Woodstove Exchange
Program in BC. BC Clean Air Forum 2008

Compound	Examples	Mode of toxicity
Inorganic gases	carbon monoxide ozone nitrogen dioxide	asphyxiant irritant irritant
Hydrocarbons	40+ unsaturated (1,3-butadiene) 25+ saturated (n-hexane) 20+ polycyclic aromatics (benzo[a]pyrene) 28+ monoaromatics (benzene, styrene)	carcinogens neurotoxins carcinogens carcinogens
Oxygenated organics	20+ aldehydes (acrolein, formaldehyde) 25+ organic alcohols (methanol, acetic acid) 33+ phenols (catechol, cresol) quinones (hydroquinone)	carcinogens irritants irritants, carcinogens irritants, allergenic
Free radicals	semiquinone type radicals	inflammatories, possible carcinogens
Particulate matter	inhalable particles (PM10) fine particles (PM2.5)	inflammatories, allergenic

Source: Woodsmoke Health Effects: A Review (2007)
Naeher LP, Brauer M, Lipsett M, Zelikoff JT, Simpson CD, Koenig JQ, Smith KR
Inhalation Toxicology 19: 67 - 106

Organic extracts of ambient particulate matter containing substantial quantities of wood smoke were found to be 30 times more potent than extracts from cigarette smoke condensate in a mouse skin tumour study

Source: Woodsmoke Health Effects: A Review (2007)
Naeher LP, Brauer M, Lipsett M, Zelikoff JT, Simpson CD, Koenig JQ, Smith KR
Inhalation Toxicology 19: 67 - 106

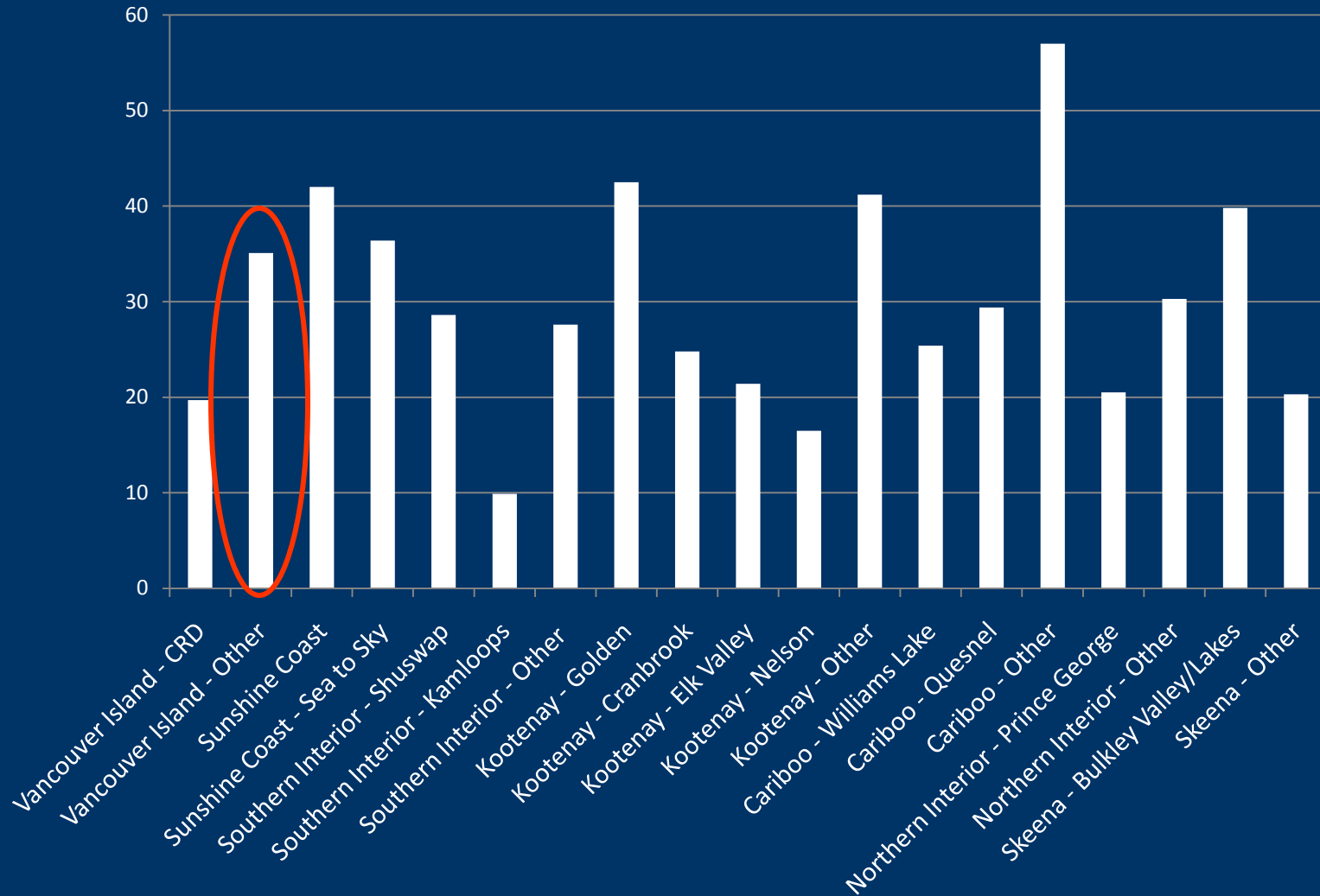
Particles associated with residential wood smoke are 3 to 5 times more likely to be inhaled than particles from other sources.

Source: Woodsmoke Intake Fraction for Metro Vancouver (2008)
Ries F. Presentation at the BC Lung Air Quality & Health Workshop, March 2008

Residential wood heating accounts for 15 percent of PM_{2.5} releases in British Columbia...[but] varies between rural and urban settings, as expected. Within some rural locations, residential wood heating can account for the greatest portion of PM_{2.5} compared to other source sectors.

Source: Residential Wood Burning in British Columbia - Public Behaviour and Opinion (2006). Xue, H and Wakelin T. BC Ministry of Environment, Environmental Protection Division.

Percent of Households Burning Wood or Pellets



Source: Residential Wood Burning in British Columbia - Public Behaviour and Opinion (2006). Xue, H and Wakelin T. BC Ministry of Environment, Environmental Protection Division.

Health Effects in the General Population

Studies in areas where wood smoke is a significant portion of ambient PM

- In Seattle, a significant association was observed between PM₁₀ levels and emergency room visits for asthma, with effects seen at levels as low as 15 ug/m³
- In Christchurch NZ, hospital admissions for respiratory and cardiac complaints increased with PM₁₀ levels (wood smoke ~ 90% of winter PM₁₀)

Studies of wood stove or fireplace use

- In Denver, use of a woodstove or fireplace by asthmatics was associated with increased daily moderate or severe shortness of breath more strongly associated than use of gas stove or occupational exposures)
- Connecticut and Virginia, each hour-per-day of fireplace use was associated with cough, sore throat, and chest tightness (not found for woodstove use, suggesting greater indoor emissions from fireplaces)

Health Effects in Children

Studies where wood smoke is a significant portion of ambient PM

- Asthmatic children are affected by ambient levels of PM_{2.5} associated with wood smoke (ie during heating season, night-time only)
 - measurable decreases in lung function
 - increased visits to emergency departments
 - increased hospitalizations for asthma

Studies of wood stove or fireplace use

- Symptoms have been seen to be significantly elevated in children living in homes with woodstoves
 - congestion, wheeze, cough, nocturnal awakening, acute lower respiratory infections (bronchiolitis or pneumonia), *maybe* otitis media (inner ear infections)

There are studies that do NOT show effects: variability among individuals, pollutant levels/constituents, etc., are all factors that interplay in complex ways – no easy answers, still:

“Significant exposures to ambient wood smoke do occur in developed countries and... important health effects have been demonstrated to result.”

Source: Woodsmoke Health Effects: A Review (2007)

Naeher LP, Brauer M, Lipsett M, Zelikoff JT, Simpson CD, Koenig JQ, Smith KR

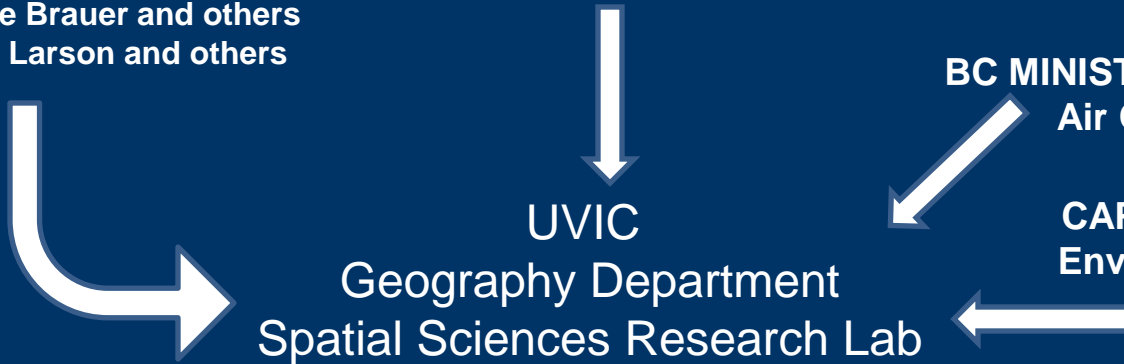
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HEALTH CANADA
BORDER AIR QUALITY STUDY
UBC – Mike Brauer and others
UW – Tim Larson and others

VANCOUVER ISLAND HEALTH AUTHORITY
Population Health Surveillance Unit

BC MINISTRY OF ENVIRONMENT
Air Quality Divisions

CAPITAL REGIONAL DISTRICT
Environmental Services – Solid
Waste Management



UVIC
Geography Department
Spatial Sciences Research Lab

Eleanor Setton
plus graduate students

RADIANCE RESEARCH M309 NEPHELOMETERS – UVIC (2) VIHA (2) MOE (1)

CRD Wood smoke Model

Nanaimo Regional District

CRD Infiltration of Outdoor PM_{2.5} to Indoor
Environments

Cowichan Valley Regional District

City of Campbell River

James Bay Air Quality Study

Comox Valley Regional District

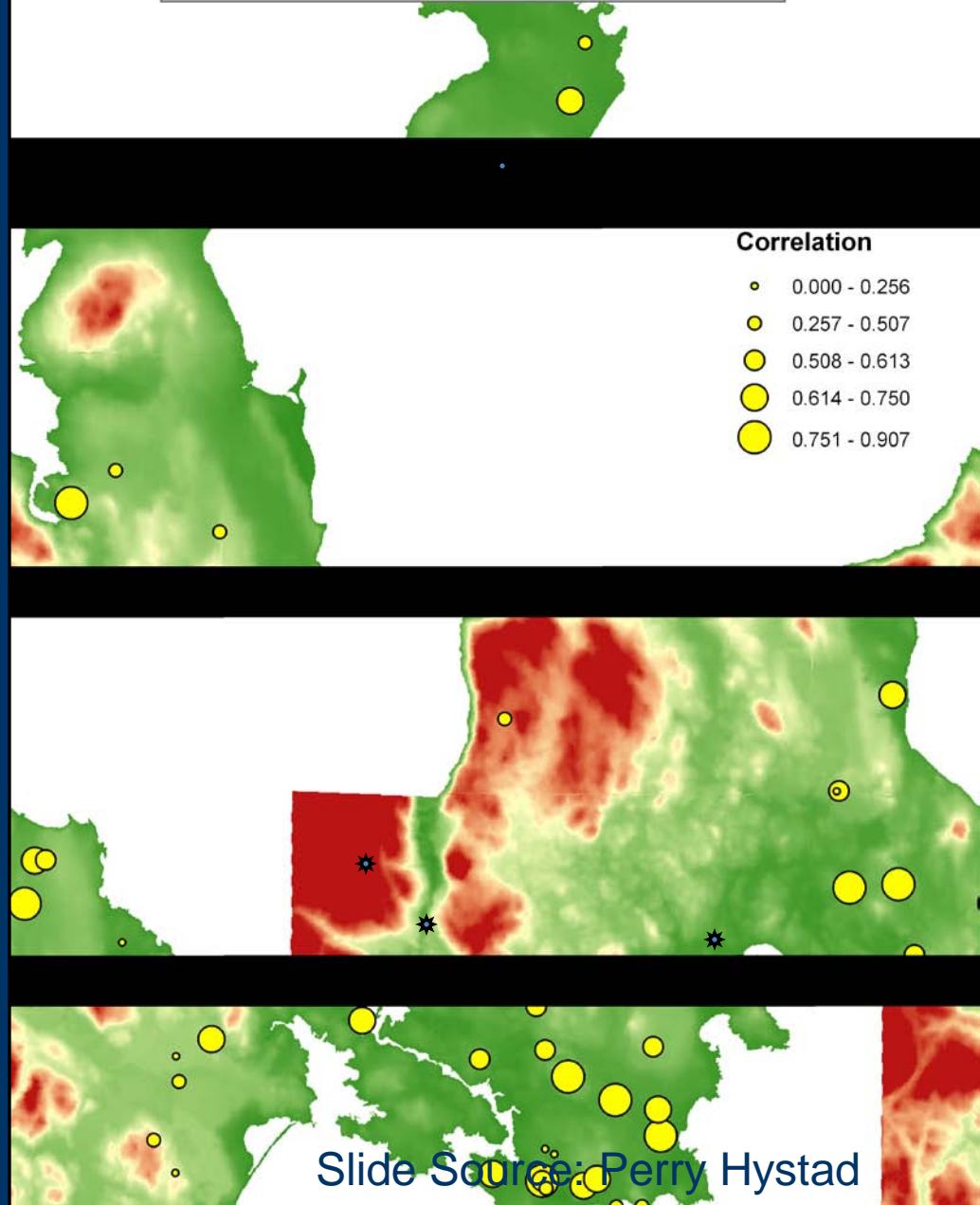
CRD Backyard Burning

Equipment support to the WEST study

Monitoring PM_{2.5} levels

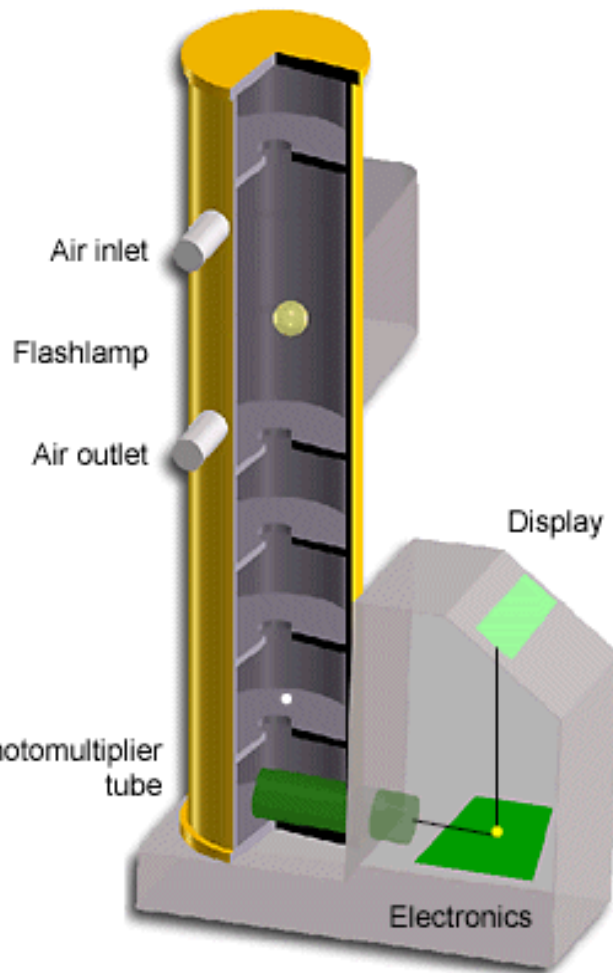
- Only larger population centres have monitoring
- Outside of the GVRD, most communities have only a few monitors
- PM levels can vary within communities, and this may not be captured by existing fixed-site monitors

Home Outdoor Correlations to Nearest Fixed Site Monitor



Slide Source: Perry Hystad

Integrating Nephelometer



The integrating nephelometer operates on the principle of the scattering of light by particulate matter

In the instrument a lamp flashes inside a matt-black tube containing baffles to minimise reflected light.

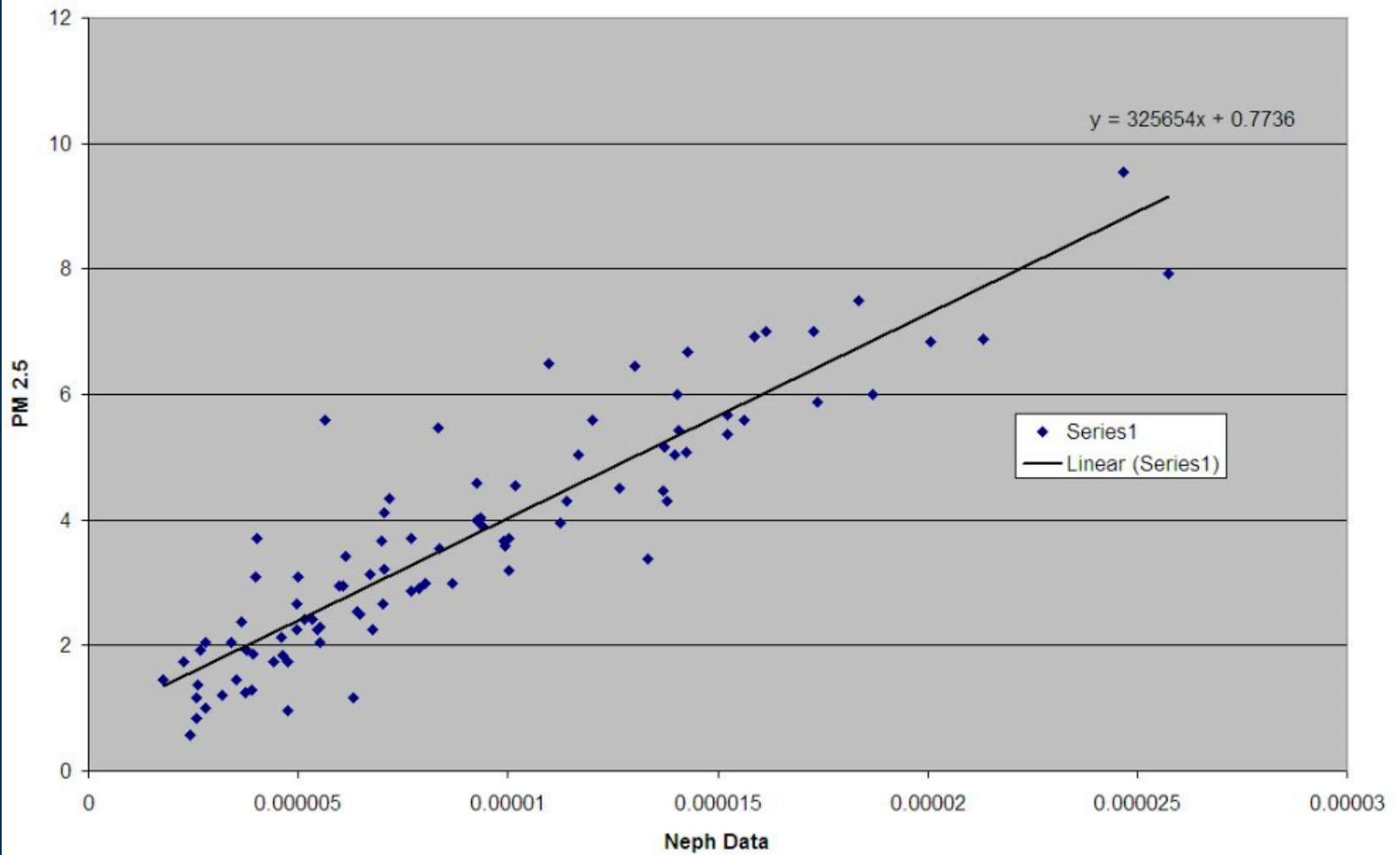
Particles suspended in the air sample in the chamber reflect light, which is detected by a photomultiplier tube, amplified and displayed.

The light-scattering coefficient (a measure of the amount of scattering) can be used to estimate visibility

The instrument is particularly sensitive to very small smoke particles, common during bushfires



Neph vs. TEOM PM2.5 (24-hour values) in Nanaimo Winter 2005/06



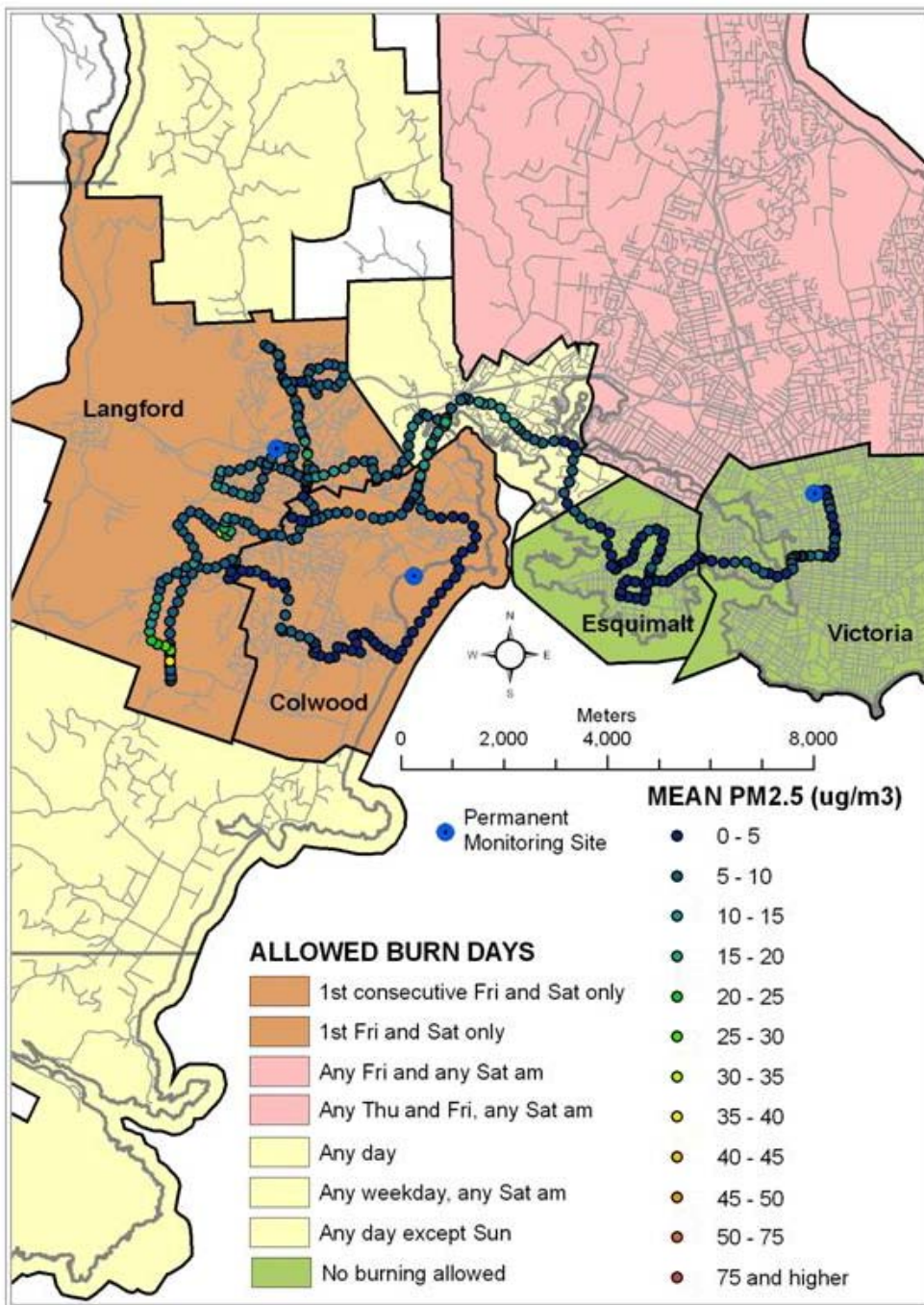


TIM LARSON – University of Washington

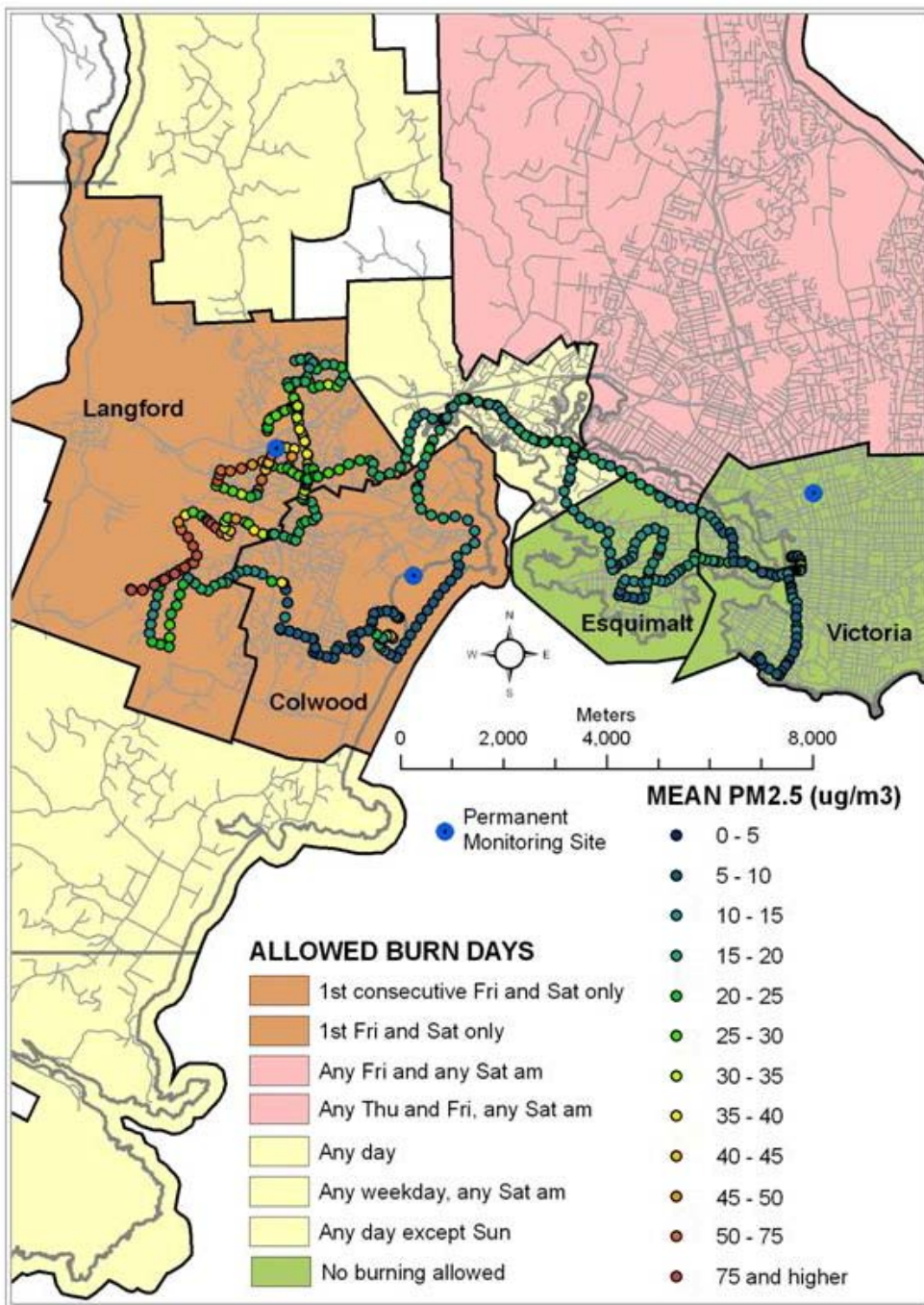
BACK YARD BURNING

Eleanor Setton, PhD, Karla Poplawski, Christy Lightowlers MSc

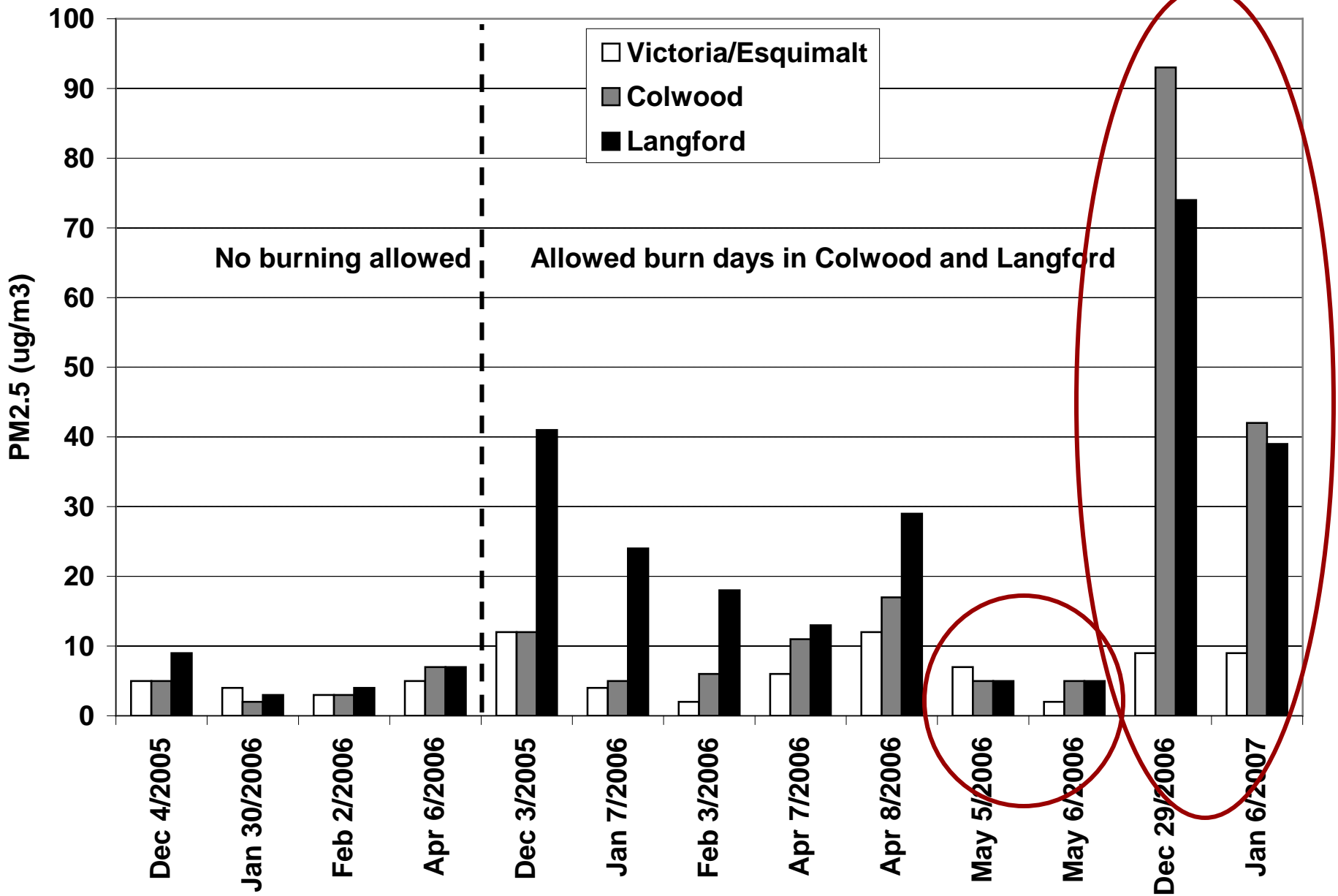
**Funded by Health Canada as part of the Border Air
Quality Study, BC Ministry of Environment, the
Vancouver Island Health Authority, and the CRD**



December 4, 2005 - No burning



December 3, 2005 - Burning in Colwood and Langford



Average of PM_{2.5} data collected on each day for Victoria/Esquimalt, Colwood and Langford based on 90 percent of data (upper and lower 5 percent removed)

COMOX RESIDENTIAL WOODSMOKE AND BEACHFIRE IMPACTS

Vancouver Island Health Authority

Michael Pennock

Alan Kerr

James Whalen/, Christine Bender

Fiona Lawson

Claudette Erdman

Charmaine Enns

Dave Cherry

Comox Valley Regional District

Beth Rees, Karin Albert, Leigh Carter

Courtenay

N Henderson, K Lagan

Comox

Richard Kanigan

BC Ministry of Environment

Earle Plain

Resident representative

Paul Horgen

Particulate Matter Concentrations in the Comox Valley - Dec. 8, 2008 (pm)

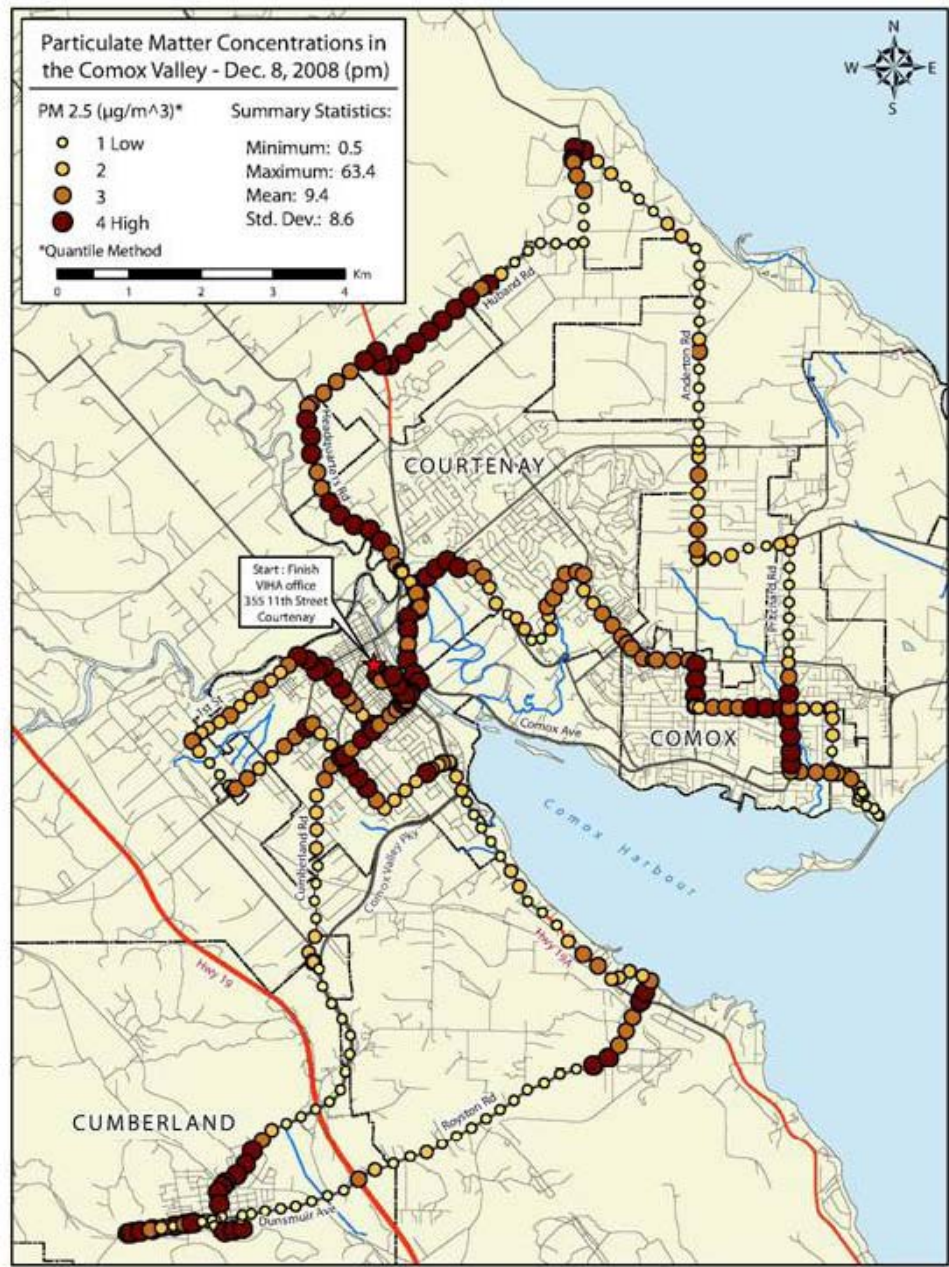
PM 2.5 ($\mu\text{g}/\text{m}^3$)*

- 1 Low
- 2
- 3
- 4 High

Summary Statistics:

Minimum: 0.5
Maximum: 63.4
Mean: 9.4
Std. Dev.: 8.6

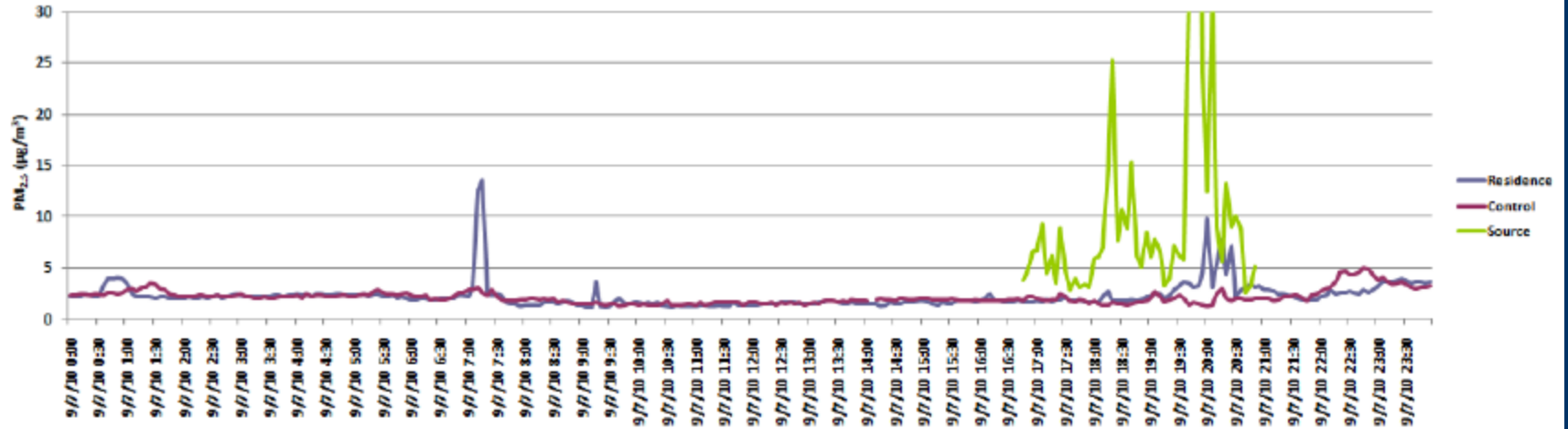
*Quantile Method



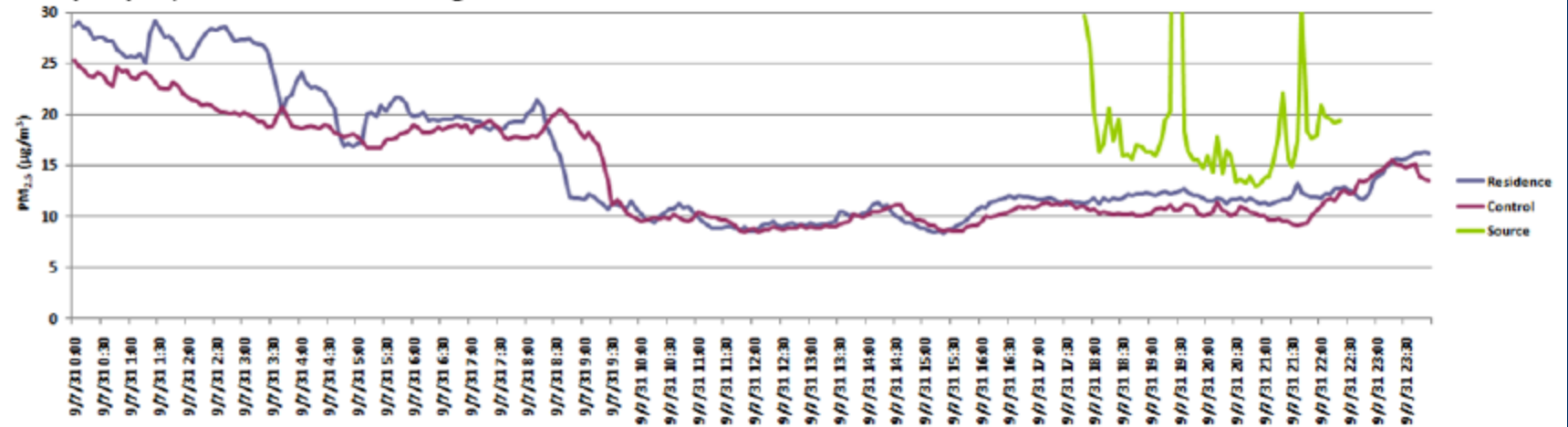
Community-based study with the overall objectives of:

- Understanding general $\text{PM}_{2.5}$ levels in the region – day and night
- Monitoring beach fire impacts
- Providing data to help site a permanent $\text{PM}_{2.5}$ monitor-background levels or exposure levels?

Friday July 10, 2009: 5-Minute Averages



Friday July 31, 2009: 5-Minute Averages



THANK YOU!

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