Exploring New Models for Occupational Cancer Surveillance in Canada

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Occupational Cancer Research Centre’s Research Program Focus Areas

1. Identification of causes of cancer in the workplace
2. Surveillance of occupational cancers & workplace exposures
3. Intervention research to develop & evaluate prevention & exposure reduction strategies
What is Surveillance?

from the US Centers for Disease Control:

“Epidemiological surveillance is the on-going, systematic collection, analysis, and interpretation of health data essential to the planning, implementation, and evaluation of public health practice, closely integrated with the timely dissemination of these data to those responsible for prevention and control”
What is Surveillance?

from the *Dictionary of Epidemiology*:

“the *ongoing scrutiny* [of the occurrence of disease, injury, or hazards] generally using methods distinguished by their *practicality, uniformity, and frequently their rapidity, rather than by complete accuracy*. Its main purpose is *to detect changes in trends or distributions* in order *to initiate investigative or control measures*”
Why Occupational Cancer Surveillance?

• Monitoring of patterns and trends
• Quick data to answer policy relevant questions
• Address new hypotheses
• Generate new hypotheses
• Provide preliminary data before more rigorous study
WSIB Accepted Workplace Fatalities: 1997–2010


Any interpretations made from the data provided by the AWCBC are from the Occupational Cancer Research Centre and do not necessarily reflect the views of the AWCBC or any of its member Boards or Commissions.
Mesothelioma* age-standardized incidence rates† by Public Health Unit, Males, 1986–2007

Statistical significance
- Lower than Ontario
++ Higher than Ontario

Rate per 100,000
Ontario‡ = 1.64
0.99 - 1.34
1.35 - 1.47
1.48 - 1.71
1.72 - 2.19
2.20 - 8.25
Insuff. data^

Notes:
*ICD-O-3 morphology 905.
†Rates are per 100,000 and age-standardized to the 1991 Canadian population.
‡Excluding unknown PHU (N=15).
§Significantly higher/lower than for Ontario.
*Statistic not displayed due to fewer than 10 cases.

Report date: Sept 2011, Data source: Cancer Care Ontario (Ontario Cancer Registry, 2011)
Prepared by: Cancer Care Ontario, Prevention and Cancer Control (Surveillance and Research)

Map Created: 2/Nov/11

Towards a cancer-free workplace
Sinonasal cancer incidence rates, Ontario, 1981–2007, both sexes combined

Source: Cancer Care Ontario (Ontario Cancer Registry, 2011)
Rates are adjusted to the age distribution of the 1991 Canadian population
Occupational Cancer Surveillance: Major Challenges

• Clinical and pathological expression of cancers do not generally differ by cause

• Compensation records only capture a small fraction of occupational cancers

• Administrative health data do not include information on occupation and industry

• Relevant time period for exposure is 10-40 years prior to diagnosis
Occupational Cancer Surveillance based on Death Certificates
Occupational Cancer Surveillance based on Death Certificates

• Occupational Mortality in British Columbia*
  – Death Certificates coded from 1950-1984

<table>
<thead>
<tr>
<th>Population</th>
<th>Sinonasal Cancer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cabinet and Furniture Makers</td>
<td>PMR (obs, 95% CI)</td>
</tr>
<tr>
<td>Carpenters</td>
<td>0.00 (0 observed)</td>
</tr>
<tr>
<td>Sawyers</td>
<td>0.77 (3, 0.15-2.24)</td>
</tr>
<tr>
<td>Woodworking Machine Operators</td>
<td>3.11 (1, 0.07-17.32)</td>
</tr>
<tr>
<td></td>
<td>7.96 (1, 0.20-44.37)</td>
</tr>
</tbody>
</table>

NIOSH Safety and Health Topic:
National Occupational Mortality Surveillance (NOMS)

Overview of the NOMS System

National Occupational Mortality Surveillance (NOMS) is the ongoing systematic collection, analysis, and dissemination of death data to monitor the extent and severity of occupationally related acute and chronic disease and injury in association with industrial or occupational settings. Statistical results from the proportionate mortality analysis of these data are available in the form of a query system for access to precalculated PMRs by occupation or industry. Recently, PMR Charts and Tables were added that present proportionate mortality for cancer, neurologic, cardiovascular, diabetes, and renal disease and other chronic disease. More Information on the NOMS System.

Occupational Mortality Statistics

- NOMS PMR Query System
  - PMR Charts and Tables for Cancer and Chronic Disease (New!)
  - PMRs By Occupation and Cause Of Death
  - PMRs by Industry and Cause of Death

- About NOMS PMRs
  - Methods and Data Sources
  - Suggested Citation
  - Note to Users
  - Industry/Occupation Coding

http://www.cdc.gov/niosh/topics/surveillance/NOMS/
Occupational Cancer Surveillance based on Death Certificates

- Questions regarding validity for occupation and industry on death certificates
- Limited cancer information and questions regarding data quality
- Proportionate mortality ratios (PMRs) may be difficult to interpret
  - SMRs sometimes used but Census a poor match with death certificates
Team Links Cancer Risks to How and Where We Live

Traditionally, surveillance systems have provided information on the prevalence of a disease or condition. Although helpful, this kind of system can’t provide clues as to why these rates are higher, nor point to potential solutions.

Health Canada’s National Enhanced Cancer Surveillance System (NECSS) provides information on geographic and behavioural factors that may influence the prevalence of disease.

Headed up by Dr. Yang Mao, the NECSS was built by collecting information from a Canada-wide sample of 20,755 recently diagnosed patients with cancer and 5,039 population controls. Each individual completed a detailed, risk factor questionnaire. In parallel, the Environmental Quality Database was developed, which facilitates the examination of the relationships between cancer and the quality of air and water in Canada.

Together, this enhanced surveillance system helps the department study both the influence of environmental factors on cancer in Canada, as well as behavioural risk factors.

Environment-Related Cancer Surveillance

The geographic component of the NECSS is very important in determining potential environmental risk factors for cancer and creating the potential to reduce the associated health risks. For example, Dr. Mao’s team has conducted a study of residential proximity to industrial plants and non-Hodgkin’s lymphoma.
National Enhanced Cancer Surveillance System

• NECSS was a collaborative project of Health Canada and provincial cancer registries

• Included individual data from 21,020 Canadians with 1 of 19 types of cancers and 5,039 population controls ages 20 to 76

• Data collected 1994 to 1997 in 8 provinces

• A one time effort
Linkage of Census or other large Cohorts & Cancer Records

- Large, hopefully representative populations
- Mimics a prospective cohort study
- Occupation and industry more reliable (although only for a single point in time)
- Lacks information on potential confounders
Large Cohort Linkage in Canada

Survey of 10% of the Canadian labour force in 1965

Annual surveys 1965-69 & 1971

~700,000 cohort members

Mortality follow-up to 1991

143,000 deaths

28,000 comparisons (specific occupation-cause of death pairs)
Course material from the NIVA-course held in Mariehamn, Aland 29-31 Aug 2011 can be found here

Nordic Occupational Cancer Study (NOCCA)

We present up to 45 years of cancer incidence data by occupational category for the Nordic populations. The study covers the 15 million people aged 30-84 years in the 1960, 1970, 1980/1981 and/or 1990 censuses in Denmark, Finland, Iceland, Norway and Sweden, and the 2.8 million incident cancer cases diagnosed in these people in a follow-up until about 2005.

Further studies will focus on associations between specific work-related factors and well-defined cancer diseases with the aim to identify exposure-response patterns. In addition to the cancer data demonstrated in the incidence publication, the NOCCA project produces a Nordic Job Exposure Matrix (JEM) that transforms information about occupational title histories to quantitative estimates of specific exposures. The third essential component is methodological development targeted at better interpretation of results based on averaged information of exposures and co-factors in the occupational categories.

This study was financially supported by the Nordic Cancer Union and Scientific Council In Sweden.

http://astra.cancer.fi/NOCCA/
The Nordic Occupational Cancer Study (NOCCA)

• Collaboration of the Finnish Cancer Registry, Norwegian Cancer Registry, Karolinska Institut, University of Copenhagen, and Icelandic Cancer Registry

• Follow-up of 15 million age 30-64 in the 1960, 1970, 1980, and 1990 Census of Sweden, Finland, Denmark, Norway, and Iceland

• 45 years of follow-up and 1.4 million cancers observed
Cancer Among Firefighters
<table>
<thead>
<tr>
<th>Cancer Site</th>
<th>Obs</th>
<th>SIR</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stomach</td>
<td>128</td>
<td>1.10</td>
<td>0.93-1.31</td>
</tr>
<tr>
<td>Colon</td>
<td>198</td>
<td>1.15</td>
<td>1.00-1.32</td>
</tr>
<tr>
<td>Rectum</td>
<td>117</td>
<td>0.98</td>
<td>0.82-1.18</td>
</tr>
<tr>
<td>Larynx</td>
<td>31</td>
<td>1.07</td>
<td>0.73-1.52</td>
</tr>
<tr>
<td>Lung</td>
<td>307</td>
<td>0.98</td>
<td>0.87-1.09</td>
</tr>
<tr>
<td>Mesothelioma</td>
<td>17</td>
<td>1.59</td>
<td>0.91-2.50</td>
</tr>
<tr>
<td>Prostate</td>
<td>654</td>
<td>1.14</td>
<td>1.05-1.23</td>
</tr>
<tr>
<td>Testicular</td>
<td>8</td>
<td>0.46</td>
<td>0.20-0.91</td>
</tr>
<tr>
<td>Malignant melanoma</td>
<td>108</td>
<td>1.25</td>
<td>1.03-1.51</td>
</tr>
<tr>
<td>Other skin cancer</td>
<td>116</td>
<td>1.33</td>
<td>1.11-1.59</td>
</tr>
<tr>
<td>Brain</td>
<td>63</td>
<td>0.86</td>
<td>0.66-1.09</td>
</tr>
<tr>
<td>Non-Hodgkin’s lymphoma</td>
<td>81</td>
<td>1.04</td>
<td>0.83-1.29</td>
</tr>
<tr>
<td>Leukemia</td>
<td>54</td>
<td>0.91</td>
<td>0.69-1.19</td>
</tr>
</tbody>
</table>

* Male Swedish, Finnish, Norwegian, and Danish Firefighters
Cancer Incidence by Age at Risk

Towards a cancer-free workplace
Methods: 1991 Canadian Census Linkage Cohort

- 1991 Long-Form Census
  - Representative 20% sample of population
- Linked to:
  - Canadian Mortality Database
    - Vital statistics
  - Canadian Cancer Database
    - Cancer incidence registry
  - Tax Summary Files
    - Derived from personal tax returns
- Follow-up: 1991 – 2003 (to be extended to 2008 later this year)
Methods: Occupation & Industry

• Occupation determined by:
  – Job or business in the week prior to the 1991 Census
• If no job in the last week:
  – Recorded job of longest duration since 1/1/1990
• If more than 1 job:
  – Recorded job where most hours were worked
• Coding:
  – Canadian “Standard Occupational Classification”
  – Canadian “Standard Industrial Classification”
Methods

1991 Long-Form Census Respondents (20% of Population)

Excluded:
Age < 25 years

Census Respondents
Age > 25 years

Excluded:
20% could not be linked

Linked
Census Respondents
Age > 25 years
Canadian National Cohort
N = 2,734,800

Men
N = 1,342,100

Women
N = 1,392,700

Working
N = 1,123,500

Working
N = 953,600
Analysis

• Survival analysis:
  – Cox proportional hazards modeling
  – All analyses within the linked cohort

• Base models: sex, age and province

• Socioeconomic status
  – Income - Ratio of neighborhood quintiles
    • 1 (lowest) → 5 (highest) quintile
  – Education - Highest level of schooling
    • 1 (no high school) → 4 (university degree)

• Parity - Number of liveborn births
Pilot Projects

• Cancer (many sites) among firefighters and police
  – Restricted to men, compared to other working men
• Lung cancer among welders
  – Analyses restricted to men, compared to other blue collar occupations
• Ovarian cancer among many groups
  – Compared to other working women
• Sinonasal cancer among wood workers
• Laterality of upper limb melanomas among drivers compared to other occupations
### Preliminary Firefighters (n=4300) and Police (n=9700)

<table>
<thead>
<tr>
<th>Cancer site</th>
<th>Firefighters</th>
<th>95% CI</th>
<th>Police</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colon</td>
<td>1.19</td>
<td>0.78 – 1.81</td>
<td>1.08</td>
<td>0.78 – 1.49</td>
</tr>
<tr>
<td>Rectum</td>
<td>1.17</td>
<td>0.69 – 1.98</td>
<td>1.19</td>
<td>0.81 – 1.75</td>
</tr>
<tr>
<td>Prostate</td>
<td>0.94</td>
<td>0.71 – 1.24</td>
<td>1.18</td>
<td>0.97 – 1.43</td>
</tr>
<tr>
<td>Testicular</td>
<td>1.94</td>
<td>0.87 – 4.34</td>
<td>1.60</td>
<td>0.90 – 2.84</td>
</tr>
<tr>
<td>Brain</td>
<td>1.18</td>
<td>0.53 – 2.63</td>
<td>0.37</td>
<td>0.14 – 0.99</td>
</tr>
</tbody>
</table>
Lung Cancer among Welders

- Overall there were 10,300 lung cancers among men in the cohort
- There were 125 lung cancers among 12,900 male welders
- Comparisons were made to all working men and blue collar men
## Lung Cancer among 12,900 Male Canadian Welders

<table>
<thead>
<tr>
<th>Category</th>
<th>Cases</th>
<th>Base Model HRR (95% CI)</th>
<th>Full Model HRR (95% CI)</th>
<th>Blue Collar HRR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Welders</td>
<td>125</td>
<td>1.25 (1.05-150)</td>
<td>1.14 (0.95-1.36)</td>
<td>1.04 (0.87-1.25)</td>
</tr>
<tr>
<td>Construction</td>
<td>17</td>
<td>1.32 (0.82-2.13)</td>
<td>1.25 (0.78-2.01)</td>
<td>1.09 (0.68-1.76)</td>
</tr>
<tr>
<td>Metal Product Manufacture</td>
<td>46</td>
<td>1.49 (1.11-1.99)</td>
<td>1.32 (0.99-1.77)</td>
<td>1.24 (0.93-1.65)</td>
</tr>
<tr>
<td>Other Manufacture</td>
<td>18</td>
<td>1.02 (0.64-1.62)</td>
<td>0.93 (0.59-1.48)</td>
<td>0.85 (0.53-1.35)</td>
</tr>
<tr>
<td>Manufacture &amp; Repair</td>
<td>36</td>
<td>1.08 (0.77-1.50)</td>
<td>0.98 (0.70-1.36)</td>
<td>0.90 (0.65-1.25)</td>
</tr>
<tr>
<td>Other Maintenance</td>
<td>8</td>
<td>1.60 (0.80-3.19)</td>
<td>1.46 (0.73-2.92)</td>
<td>1.33 (0.66-2.66)</td>
</tr>
</tbody>
</table>
Ovarian Cancer Analyses

- Women: 1,392,700
  - Non-Working: 439,100
    - Ovarian Cancer: 1,695
  - Working: 953,600
    - Ovarian Cancer: 2,337

Mean Age: 58.7 years, SD 17.6
Parity: 2.7, SD 2.3

Mean Age: 40.4 years, SD 10.9
Parity: 1.8, SD 1.6
### Ovarian Cancer Hazard Ratios

<table>
<thead>
<tr>
<th>Occupation/Exposure</th>
<th>Base Model</th>
<th>95% CI</th>
<th>Fully Adjusted Model</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hairdressers/Barbers</td>
<td>0.72</td>
<td>0.41 – 1.28</td>
<td>0.74</td>
<td>0.42 – 1.30</td>
</tr>
<tr>
<td>Managers</td>
<td>1.10</td>
<td>0.95 – 1.28</td>
<td>1.06</td>
<td>0.91 – 1.24</td>
</tr>
<tr>
<td>Secretaries</td>
<td>1.00</td>
<td>0.86 – 1.15</td>
<td>1.00</td>
<td>0.87 – 1.16</td>
</tr>
<tr>
<td>Sales Agents</td>
<td>0.93</td>
<td>0.79 – 1.10</td>
<td>0.97</td>
<td>0.83 – 1.14</td>
</tr>
<tr>
<td>Textile Workers</td>
<td>0.87</td>
<td>0.65 – 1.15</td>
<td>0.93</td>
<td>0.70 – 1.23</td>
</tr>
<tr>
<td>Printers/Graphics</td>
<td>0.92</td>
<td>0.38 – 2.21</td>
<td>0.92</td>
<td>0.38 – 2.21</td>
</tr>
<tr>
<td>Librarians</td>
<td>1.69</td>
<td>0.88 – 3.26</td>
<td>1.51</td>
<td>0.78 – 2.92</td>
</tr>
<tr>
<td>Cooks and Stewards</td>
<td>0.90</td>
<td>0.65 – 1.26</td>
<td>0.98</td>
<td>0.71 – 1.37</td>
</tr>
<tr>
<td>Religious Workers</td>
<td>1.73</td>
<td>1.09 – 2.74</td>
<td>1.30</td>
<td>0.81 – 2.07</td>
</tr>
<tr>
<td>Nurses</td>
<td>0.99</td>
<td>0.84 – 1.16</td>
<td>0.96</td>
<td>0.82 – 1.13</td>
</tr>
<tr>
<td>Teachers</td>
<td>1.15</td>
<td>0.97 – 1.37</td>
<td>1.04</td>
<td>0.86 – 1.25</td>
</tr>
</tbody>
</table>
NOCCA* versus Canada: Sinonasal Cancer in Woodworkers

- All: Sweden, Denmark, Norway, Finland, Iceland
  - Men: SIR=1.8, 95% CI=1.7-2.0, 355 cases
  - Women: SIR=1.9, 95% CI=0.9-3.5, 10 cases

- Adenocarcinoma (excluding Iceland)
  - Men: SIR=5.5, 95% CI=4.6-6.6, 122 cases
  - Women: SIR=0, 95% CI=0-11.9

- All: Canada
  - Men: HR=0.85, 95% CI=0.4-1.9, 6 cases

1991 Census Linkage: New analyses

• Shift type and breast, prostate, and other cancers
  – Development of JEM using the 1993 SLID

• Sedentary work and colorectal cancer
  – Canadian Health Measures Survey?

• Cancer among agricultural workers
  – Assessment of geographic patterns

• More analyses using quantitative Job Exposure Matrixes with data from CAREX Canada
1991 Census Linkage: New Methods

• Assessing methods for indirectly controlling for smoking and other potential confounders
  – In collaboration with Rick Burnett and other at Health Canada

• Comparison of results using Cox modelling versus SIR approach (used in NOCCA)

• Re-run analyses with follow-up through 2008
Limitations

• Power: inability to look at rare cancers and rare occupational groups
  – Women in blue collar jobs
  – Specific industries in Ontario

• Potential for Confounding: how good of surrogates are income and education?

• Completeness and consistency of data across provinces
Alternative Model: Linkage of Tumour Registry & Workers’ Comp Records

• Occupation & Industry in electronic records for all lost-time

• Large Ontario cohort, but not representative
  – Skewed sample of labour force towards higher risk industries and occupations
  – Skewed sample of labour force (example: in 1991 84% < 50 years old and 71% male)
Census versus Workers’ Comp Records

• National versus Provincial Sample
  – Increased ability to study Ontario industries?

• Representative versus skewed cohort
  – Skewed towards exposed populations?

• Operate by Statistics Canada rules versus Ethical Review and data sharing agreements
  – Greater capabilities and speed?
Acknowledgements

• Anne Harris, Jill Hardt, Lua Eiriksson
• Collaborators:
  Paul Peters, Michael Tjepkema, Stats Can
  Rick Burnett, Health Canada
  Eero Pukkala and NOCCA

• Funders:
Towards a cancer free workplace

http://occupationalcancer.ca
Towards advancing occupational cancer research

News & Events

Student Research Prize for Occupational Cancer Research
September 23, 2010

OCRC is accepting applications for its annual Student Research Prize, a competition that recognizes the work of one student who has made a significant...

Students recruited to OCRC
September 23, 2010

OCRC continues to recruit students to work on several occupational cancer research projects. Manisha Pahwa is an occupational/environmental health graduate...

About OCRC

The Occupational Cancer Research Centre (OCRC), established in 2009, is the first of its kind in Canada. The Centre was established to fill the gaps in our knowledge of occupation-related cancers and to translate these findings into preventive programs to control workplace carcinogenic exposures and improve the health of workers.

The Centre is establishing and leading a program of integrated research that will involve collaborations between researchers, worker organizations and employers.

Read More

Featured Profile

Shelley Harris
Scientist

Biography
List of Projects
History of Census Linkage for Occupational Surveillance in Canada

- Linkage of “Long Form” Census (~15% of working population) with national mortality database
  - Cancer still based on death certificates
  - Analyses of all occupations/industries without use of other Census data or a priori hypotheses
    - versus -
  - Hypothesis driven analyses
Previous Studies of Firefighters

• Intermittent high exposure to carcinogens

• Meta-analysis of 21 cancer in 32 studies in 2006\(^1\)
  – Multiple myeloma, NHL, prostate & testicular probably associated
  – Skin, brain, rectum, buccal cavity and pharynx, stomach, and colon cancer, as well as malignant melanoma and leukemia possibly related

• 2007 IARC monograph working group review of 42 studies\(^2\)
  – Strongest evidence was for testicular cancer, prostate cancer & NHL

Surveillance of environmental & occupational exposures for cancer prevention

Surveillance de l'exposition aux agents cancérigènes en milieu de travail et dans l'environnement pour la prévention du cancer
Mean Wood Dust Concentration by Year: Ontario

-Towards a cancer-free workplace
## Wood Dust Concentration by Industry

<table>
<thead>
<tr>
<th>Industry</th>
<th>N</th>
<th>Range</th>
<th>GM</th>
<th>GSD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mining and oil and gas extraction</td>
<td>6</td>
<td>0.05-2.9</td>
<td>0.7</td>
<td>4.3</td>
</tr>
<tr>
<td>Construction</td>
<td>162</td>
<td>0.02-41</td>
<td>2.0</td>
<td>4.4</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>2975</td>
<td>0.02-50</td>
<td>2.1</td>
<td>3.6</td>
</tr>
<tr>
<td>Wholesale trade</td>
<td>74</td>
<td>0.13-28</td>
<td>1.7</td>
<td>3.3</td>
</tr>
<tr>
<td>Retail trade</td>
<td>17</td>
<td>0.10-10</td>
<td>1.6</td>
<td>4.1</td>
</tr>
<tr>
<td>Real estate and rental and leasing</td>
<td>14</td>
<td>0.05-32</td>
<td>4.0</td>
<td>5.4</td>
</tr>
<tr>
<td>Professional, scientific and technical</td>
<td>23</td>
<td>0.05-10</td>
<td>0.7</td>
<td>3.2</td>
</tr>
<tr>
<td>Administrative and support</td>
<td>41</td>
<td>0.02-12</td>
<td>1.3</td>
<td>4.1</td>
</tr>
<tr>
<td>Educational services</td>
<td>211</td>
<td>0.02-43</td>
<td>2.0</td>
<td>4.0</td>
</tr>
<tr>
<td>Health care and social assistance</td>
<td>87</td>
<td>0.03-38</td>
<td>2.0</td>
<td>5.3</td>
</tr>
<tr>
<td>Arts, entertainment and recreation</td>
<td>8</td>
<td>0.17-9.3</td>
<td>0.6</td>
<td>5.2</td>
</tr>
<tr>
<td>Other services</td>
<td>30</td>
<td>0.63-20</td>
<td>3.9</td>
<td>2.6</td>
</tr>
<tr>
<td>Public administration</td>
<td>21</td>
<td>0.5-20</td>
<td>3.6</td>
<td>2.7</td>
</tr>
</tbody>
</table>
Night, Evening & Rotating Workers in Ontario Industries with the Highest Prevalence

- Manufacturing
- Business, building and other support services
- Forestry, Fishing, Mining, Oil and Gas
- Accommodation and Food Services
- Trade
- Health Care and Social Assistance

The chart shows the number of male and female workers in different industries. The number of male workers is represented in blue, and the number of female workers is represented in red.
Distribution of Herbicide Use - Ontario - High Agricultural Activity Areas

Percentage of Total Farm Area Reporting Herbicide Use
- Non Agricultural Areas - Ontario
- 0.1% - 5%
- 6% - 15%
- 16% - 30%
- 31% - 50%
- 51% - 80%

Data Source: Stats Canada, Census of Agriculture 2006
Annual Recommended Chlorothalonil Use (tonnes/year)

Quantiles:
- Low (> 0 - 3)
- Low-Medium (3 - 20)
- Medium (20 - 75)
- Medium-High (75 - 200)
- High (200 - 1600)
- Other (4618)

Ecodistrict
Recommended use is estimated for Ecodistricts, but displayed by areas where agriculture is most likely to occur within each region.

*Ecodistricts of chlorothalonil-use with no estimate of location.