Mainstreaming Adaptation and Impacts Science into Solutions for Canada

Striking Back: An Assessment of Lightning-related Fatality & Injury Risk in Canada

Brian Mills
Adaptation and Impacts Research Division

Environment Canada | Environnement Canada

c/o Faculty of Environmental Studies
University of Waterloo
Waterloo, Ontario N2L 3G1
(519) 888-4567 ext.35496
Brian.Mills@ec.gc.ca

Dan Unrau
Environment Canada
Carla Parkinson
Faculty of Applied Health Sciences
University of Waterloo
Brenda Jones
Department of Geography
University of Waterloo
Jennifer Yessis
National Research Corporation
Kelsey Spring
Canadian Lightning Detection Network
Environment Canada

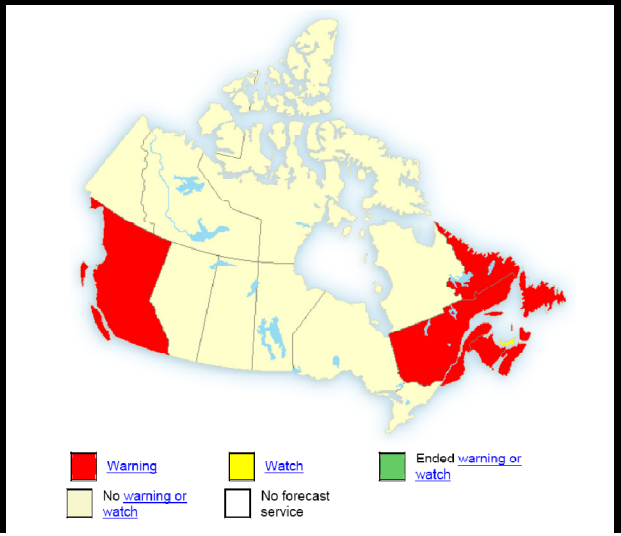
OUTLINE

- Context
  - Big picture--->Lightning
- Case Study
  - Literature review
  - Approach & Analysis
  - Results
- Summary, Recommendations & Next Steps

Environment Canada | Environnement Canada
Meteorological Service of Canada | Service météorologique du Canada

Public National Meteorological Agencies

- *Responsible for issuing watches, advisories and warnings (WAW) for high impact weather based on interpretation of numerical model output, expertise, and monitoring of current conditions/trends*
- *Primary outcome is ensuring health and safety of the public*



http://www.weatheroffice.ec.gc.ca/warnings/warnings_e.html

Environment Canada | Environnement Canada

Meteorological Service of Canada | Service météorologique du Canada

Public National Meteorological Agencies

In terms of user (public) relevant WAW products…

- *A few examples of explicit recognition of user-relevant thresholds (e.g., revised windchill factors, UV radiation forecasts)*
- *Much greater reliance on implicit or subjective interpretations of "high impact" or dangerous conditions is evident*
- *Little objective sense of baseline risks and influence of specific warning messages (precision+accuracy=behavioural change)*

Winter Storm/Snowfall Warnings

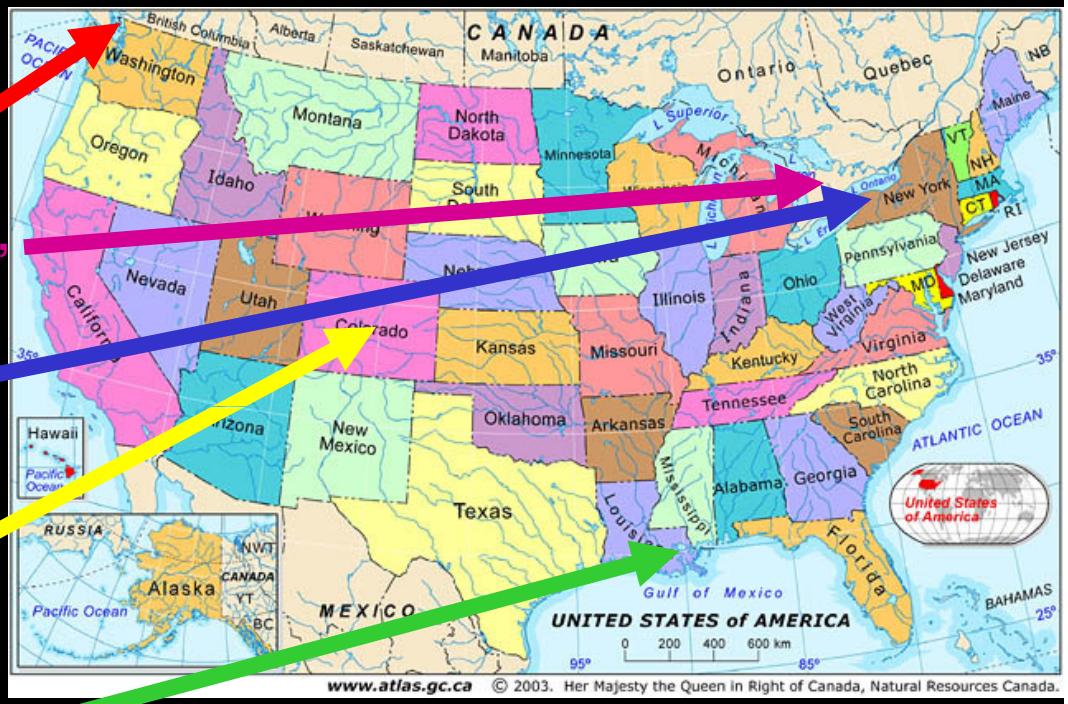
5cm(2.5in) in 24h (snowfall warning)

25cm(10in) in 24h or 2 or more snowfall, ZR, wind…criteria met

7in(17.5cm) in 12h, 9in(22.5cm) in 24h, 0.5in(1.3cm) ice, or combination heavy snow, sleet, ZR

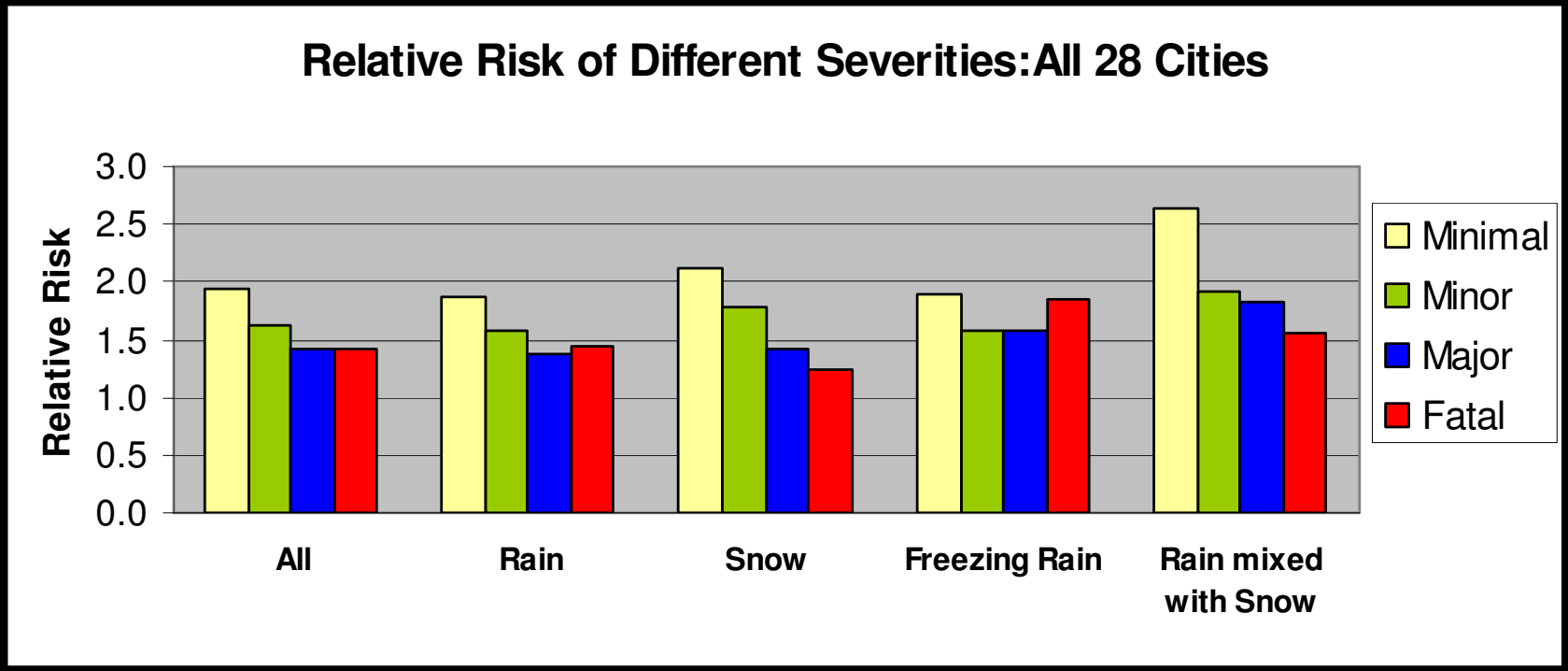
8/10in(20/25cm) in 12/24h (mtns.), 6/8in(15/20cm) in 12/24h (lower elevts.)

4in(10cm), 0.5in(1.3cm) sleet, 0.25in(0.6cm) ice, combination of snow, ZR



Source: NOAA, Environment Canada

Relative Injury Collision Risk (1984-00)



Source: Andrey (in preparation)

Relative Collision & Injury Risk - Ottawa (1996-98)

		RELATIVE RISK	
	n*	Collision	Injury
All Events	240	1.74	1.60
No watch, advisory or warning in effect within past 24 hours	207	1.80	1.68
Watch, advisory or warning in effect within past 24 hours	33	1.40	1.18

*event-control pairs

Source: Mills and Andrey (in preparation)

Environment Canada | Environnement Canada

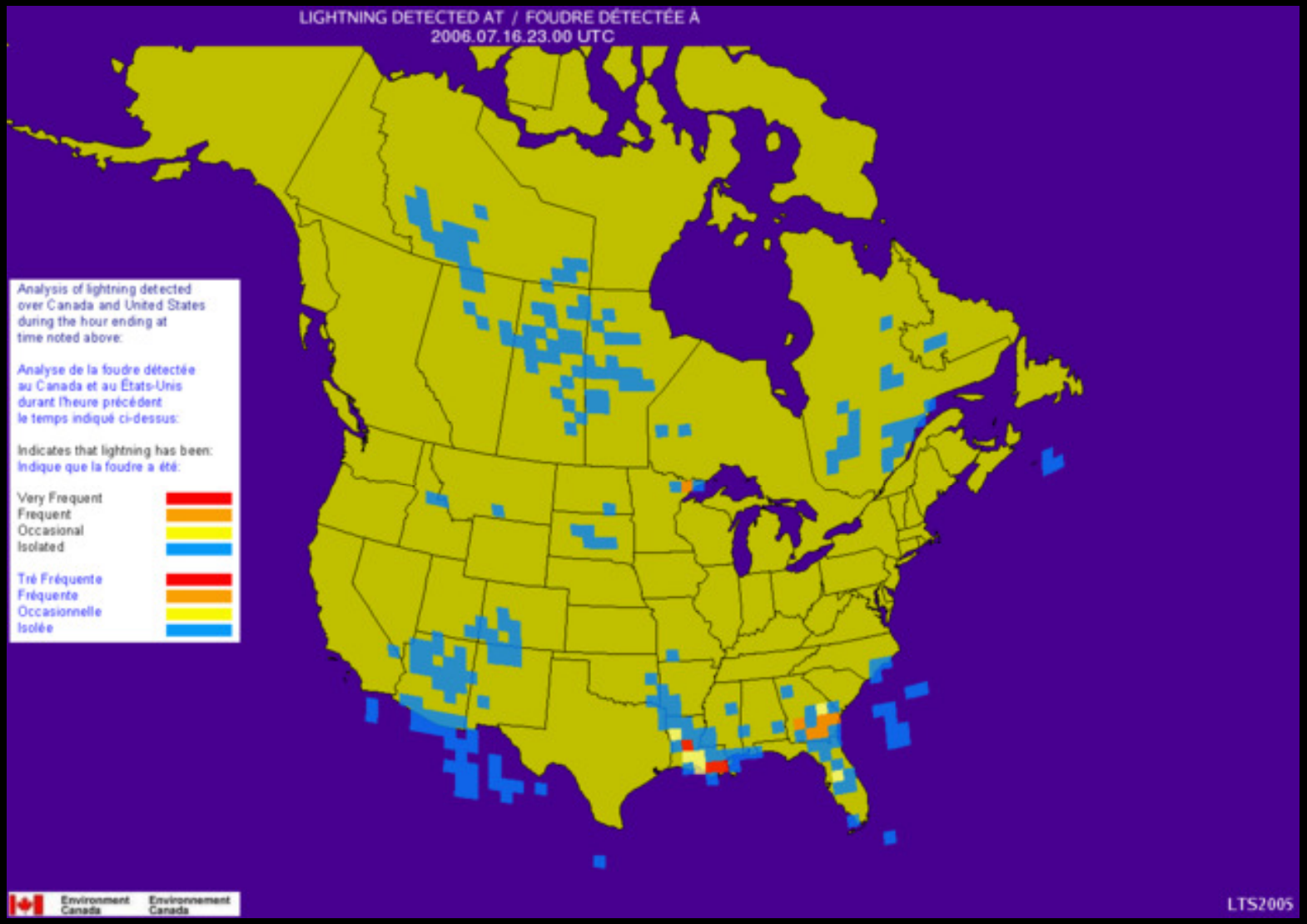
Meteorological Service of Canada | Service météorologique du Canada

Public National Meteorological Agencies

In terms of user (public) relevant WAW products…

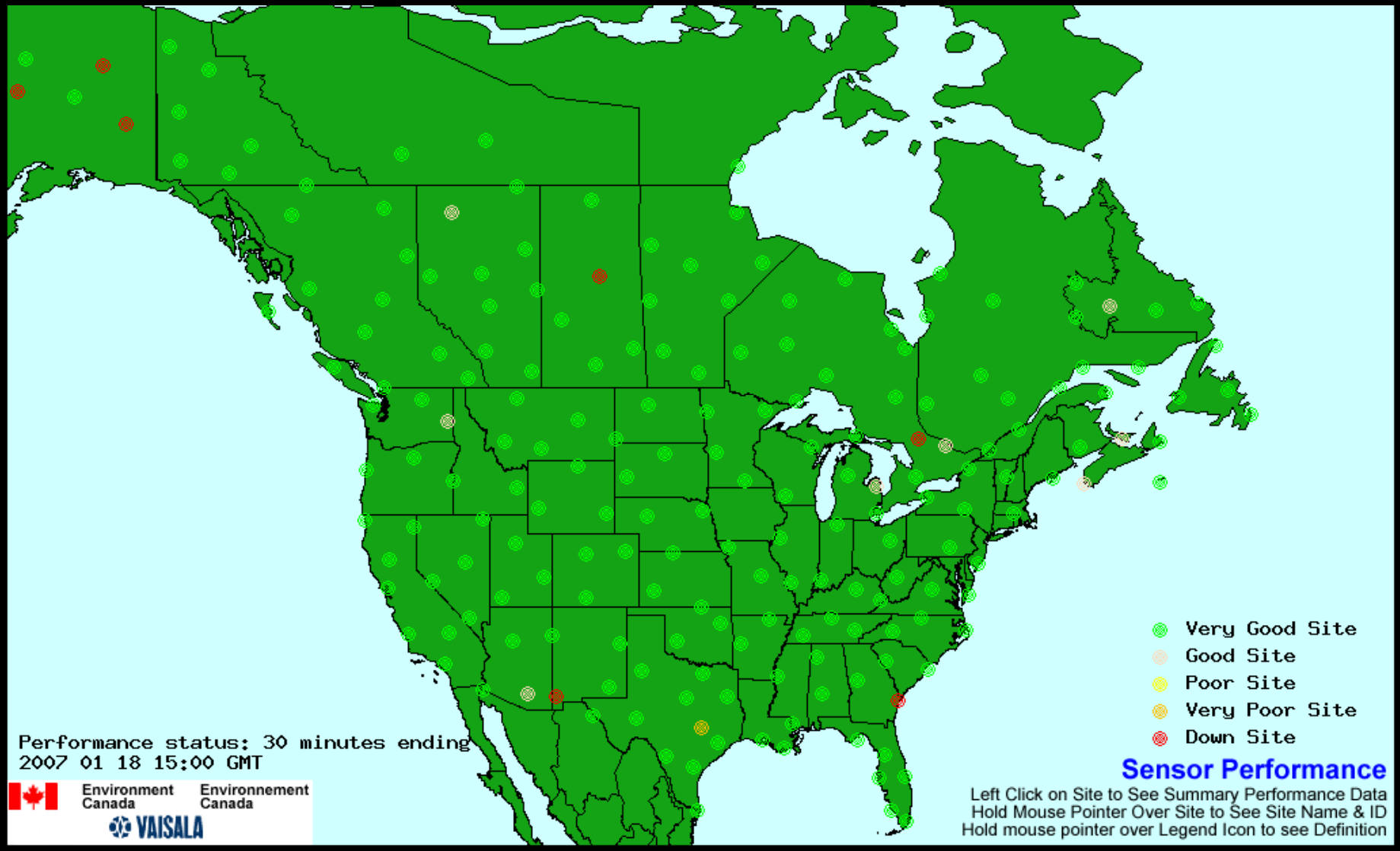
- *A few examples of explicit recognition of user-relevant thresholds (e.g., revised windchill factors, UV radiation forecasts)*
- *Much greater reliance on implicit or subjective interpretations of "high impact" or dangerous conditions is evident*
- ***Little objective sense of baseline risks** and influence of specific warning messages (precision+accuracy=behavioural change)*

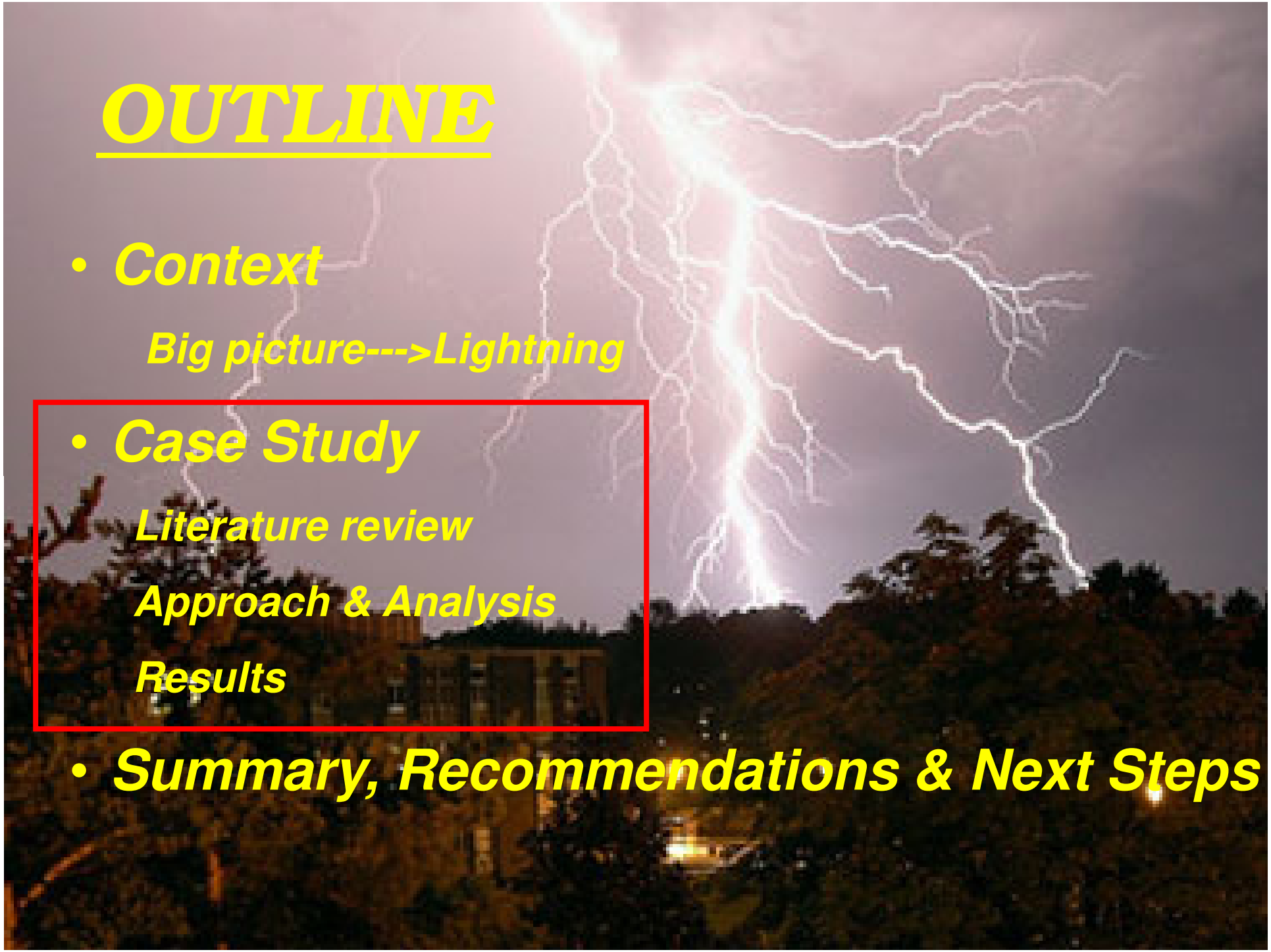
Canadian Lightning Detection Network (CLDN)



http://www.weatheroffice.ec.gc.ca/lightning/index_e.html

Canadian Lightning Detection Network (CLDN)





OUTLINE

- Context
  - Big picture--->Lightning
- Case Study
  - Literature review
  - Approach & Analysis
  - Results
- Summary, Recommendations & Next Steps

Literature Review

Author	Timeframe	Location	Deaths and injuries	Annual mortality, injury or casualty rates per million population (unless otherwise stated)	Data Sources
Bains and Hoey (1998)	1991-1995	Canada	27 deaths	n/a	Death certificates (government)
Baker (1984)	1941-1980	England and Wales	263 deaths	7.0 million to one	Unknown
Baker (1984)	1951-1980	Scotland	9 deaths	17.3 million to one	Unknown
Baker (1984)	1954-1969	Ireland	7 deaths	n/a	Unknown
Baker (1984)	1941-1980	Northern Ireland	1 death	57.1 million to one	Unknown
Cherington (2001)	1989-1995	Rocky Mountains (Colorado)	39 deaths	n/a	Newspapers
Coates *et al.* (1993)	1824-1991	Australia	650 deaths	0.08 per 100,000 (1910-89) 0.01 per 100,000 (1980-89)	Newspapers, Australian Bureau of Statistics
Curran *et al.* (2000)	1959-1994	United States	3239 deaths	0.42 (0.0-1.88, Alaska-New Mexico) 1 per 345,000 CG strikes	US NOAA Storm data
			9818 injuries	1.26 (0.0-5.74, Alaska-Wyoming)	
Duclos *et al.* (1990)	1978-1987	Florida	101 deaths	0.09 per 100,000	Death certificates, autopsy reports, Florida Hospital Cost Containment Board, US NOAA Storm data, hospitals
			44 injuries[1] (1987)	0.54 casualties[2] per 100,000 (1987)	
ten Duis (1998)	1910-1995	Netherlands	602 deaths[3]	n/a	Unknown
Elsom (1993)	1975-1990	England and Wales	56 deaths	n/a	Office of Population Censuses and Surveys
Elsom (2001)	1993-1999	United Kingdom	22 deaths	0.05 1 death per 100,000 CG strikes	Tornado and Storm Research Organisation database (reports in journals, news media, voluntary thunderstorm observer network)
			341 injuries	1 injury incident per 12,000 CG strikes	
Hornstein (1961,1962)	1939-1958	Canada	320 deaths	1.1	Bureau of Government Statistics
Lopez and Holle (1996)	1959-1990	United States	2983 deaths	n/a	US NOAA Storm Data
Lopez and Holle (1998)	1900-1991	United States	20758 deaths	0.3-6.3 (1991, 1901)	Bureau of the Census and Public Health Service (mortality and vital statistics)
			8233 injuries	n/a	
Lopez *et al.* (1993)	1980-1991	Colorado	36-51 deaths[4]	n/a	Colorado Department of Health (death certificates), US NOAA Storm Data, newspapers, Colorado Hospital Association (discharge data)
			46-82 injuries[5] (1988-1991)	n/a	
Lopez *et al.* (1995)	1950-1991	Colorado	103 deaths	n/a	US NOAA Storm Data
			299 injuries	0.1 casualties[2] per million people per 10,000km^2	
Nguyen and Bailey (2004)	1991-1996	Canada	5 deaths (0-19 years)	0.01 per 100,000 children 0-19 years old	Provincial and territorial coroners offices, Canadian Hospitals Injury Reporting and Prevention Program data
			9 injuries(0-19 years)	n/a	
Pakiam *et al.* (1981)	1956-1979	Singapore	80 deaths	1.7 (1961-79)	Meteorological Services Singapore, report on Registration of Birth and Deaths, Ministry of Health, newspapers
Shearman and Ojala (1999)	1978-1994	Michigan	39-47 deaths[6]	n/a	US NOAA Storm data, Michigan Department of Public Health (death certificates, hospital discharge records)
			203-246 injuries[7]	n/a	

[1] estimated
[2] casualties are the sum of reported deaths and injuries
[3] estimate based on figure 1 in article
[4] varied by source (36-US NOAA Storm data, 51-Colorado Department of Health
[5] varied by source (46-Colorado Hospital Association discharge data, 82-US NOAA Storm Data)
[6] varied by source (39-US NOAA Storm data, 47-Michigan Department of Health
[7] varied by source (203-Michigan Department of Health, 246-US NOAA Storm Data)

Pathways to Injury

- *Direct Hits*
- *Contact Voltage*
- *Splash or Flashover Voltage*
- *Step Voltage*

Literature Review

Body System	Types of Lightning-related Injuries
Integumentary system:	Linear, punctate, and partial- or full-thickness burns; keraunographic markings
Cardiac system:	Ventricular fibrillation; asystole; hypertension; tachycardia; nonspecific ST-segment and T-wave changes; prolonged Q-T intervals; premature ventricular contractions; myocardial infarction
Central nervous system:	Weakness; amnesia; confusion; intracranial injuries; immediate loss of consciousness; brief aphasia; paraplegia; quadriplegia; spinal cord damage; cold, mottled, pulseless extremities
Ears and eyes:	Tympanic membrane perforation; secondary otitis media; transient dizziness; temporary or permanent deafness; dilated and/or nonreactive pupils; transient blindness; corneal edema; uveitis; hyphema; vitreous hemorrhage; cataracts
Other injuries:	Myoglobinuria (rare); myalgias; hypothermia; blunt trauma (e.g., vertebral, skull, rib and extremity fractures)

Source: Lewis (1997)

Psychological trauma? Secondary injuries (fire)?

Factors that Influence Exposure

- *Temporal*

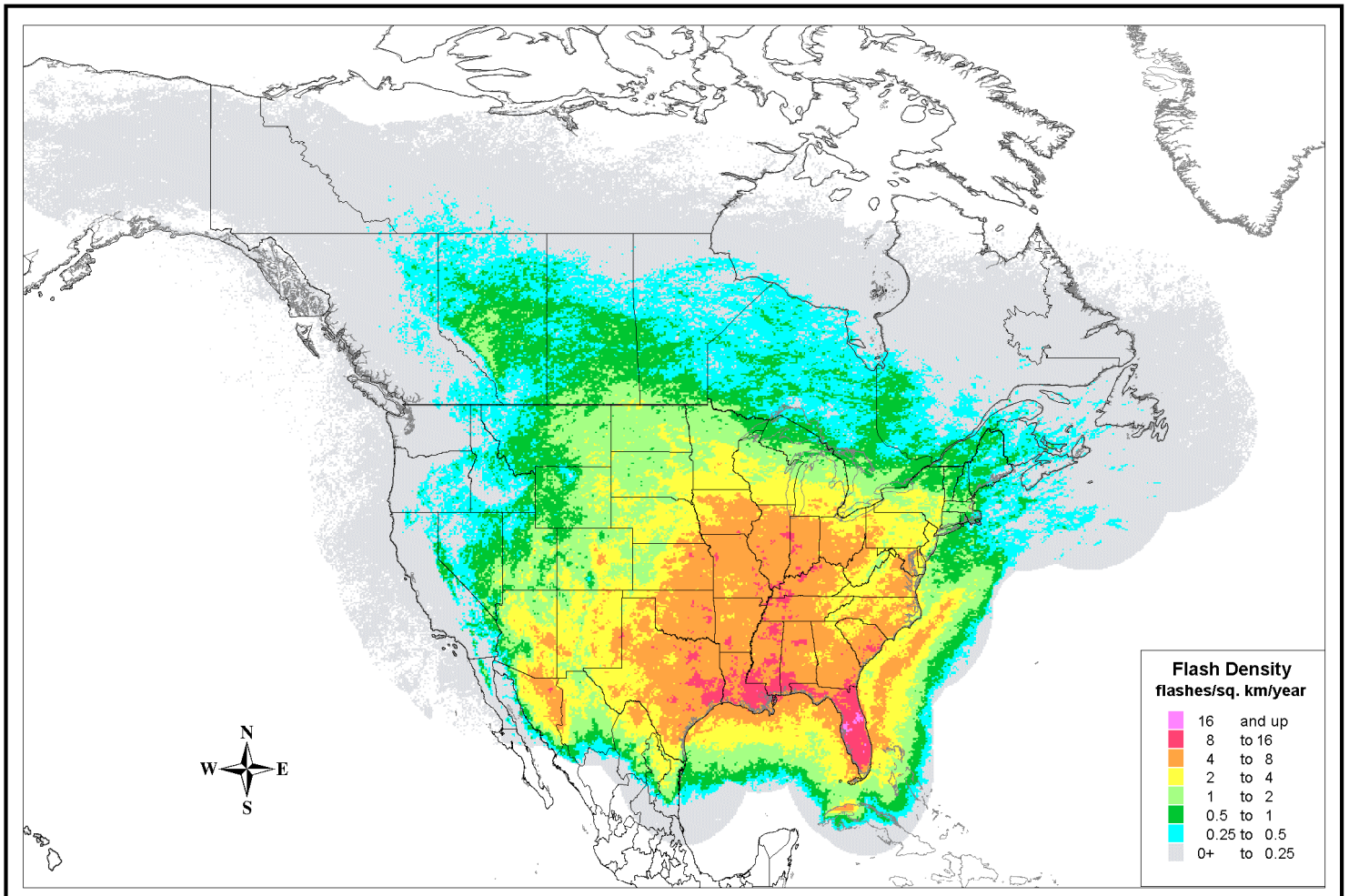
  Season, day-of-week, time-of-day

- *Geographic & socio-demographic factors*

  More people, more CG lightning—more injuries

  Outdoor recreation or employment

  Young and male



VAISALA

Lightning data source: U.S. National Lightning Detection Network®
This report generated using Vaisala FALLS® software

2000-2004 NALDN Flash Density Map

10 kilometer grid

Jan 1, 2000 00:00:00 GMT
To
Dec 31, 2004 23:59:59 GMT

Environment Canada Environnement Canada

Canadian Case Study

- *Objective*

  Assess and quantify lightning-related fatality and injury risks in Canada

- *Method: simple statistical analyses of multiple sources of readily available data*

  Official Canadian mortality and morbidity data

  Database of media (newspaper) accounts

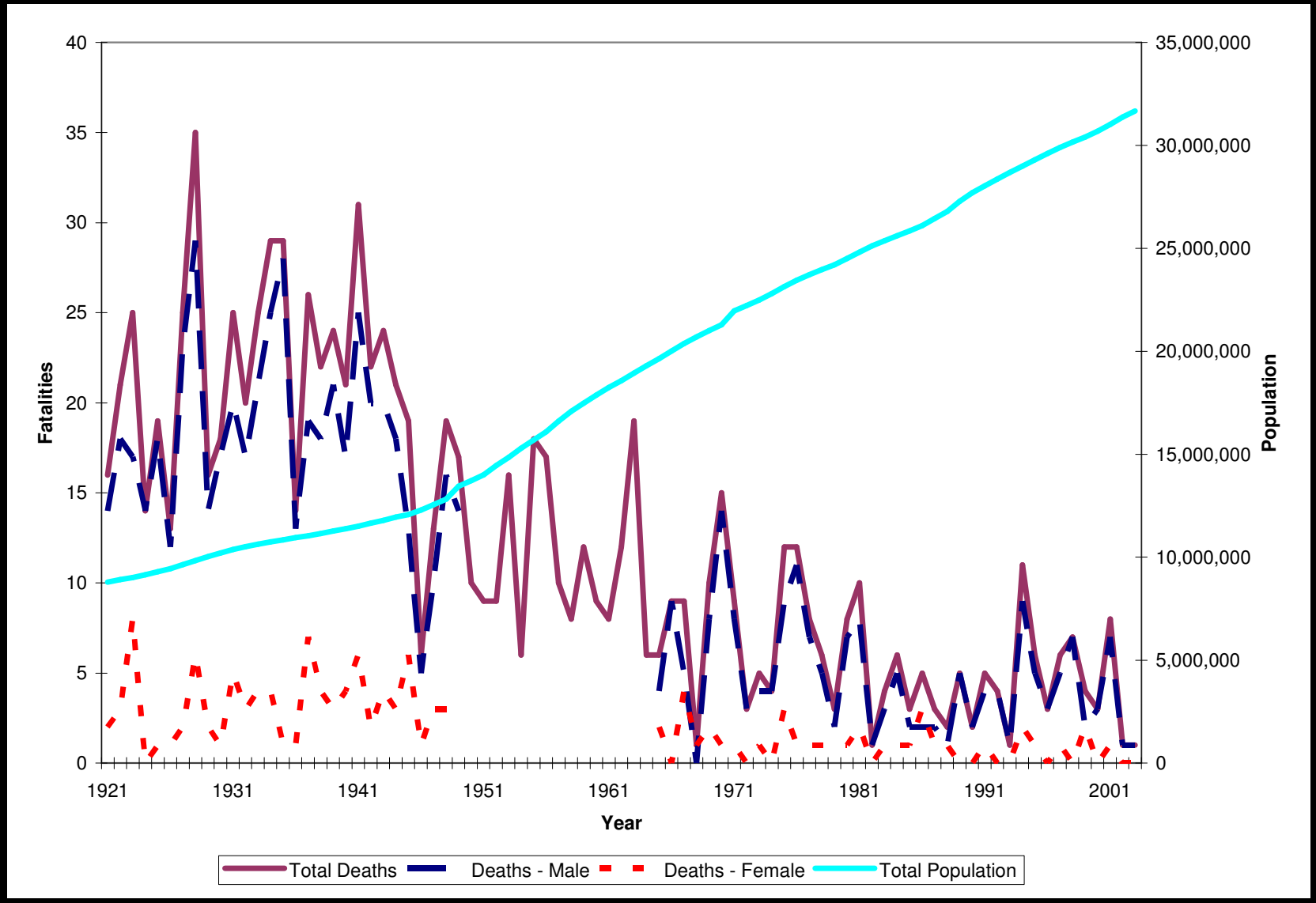
  U.S. Storm Data

Official Sources of Mortality and Morbidity Data

Data	Period	Source	Region	Completeness
Vital statistics – cause-of-death by gender	1921-2002	Statistics Canada	National and provincial (except 1950-64)	– based on ICD codes (E907) and place of residence – non-Canadians excluded
National Trauma Registry – admissions to acute care hospitals	1999-2003*	Canadian Institute for Health Information (CIHI)	National	– based on ICD-9 code (E907) and ICD-10 code (X33 victim of lightning) – data collected only for acute care hospitals
National Ambulatory Care Registry System – emergency room visits	2002-2003*	Canadian Institute for Health Information (CIHI)	Ontario	– based on ICD-10 code (X33 victim of lightning)
Injuries caused by fires ignited by lightning	1986-2001	Council of Canadian Fire Marshals and Fire Commissioners (CCFMFC)	National and provincial	– based on standard code of fires by source of ignition (CCFMFC 2002) – includes fires where response was from a government fire department – does not include forest fires that do not affect structures

*based on FY (April 1-March 31)

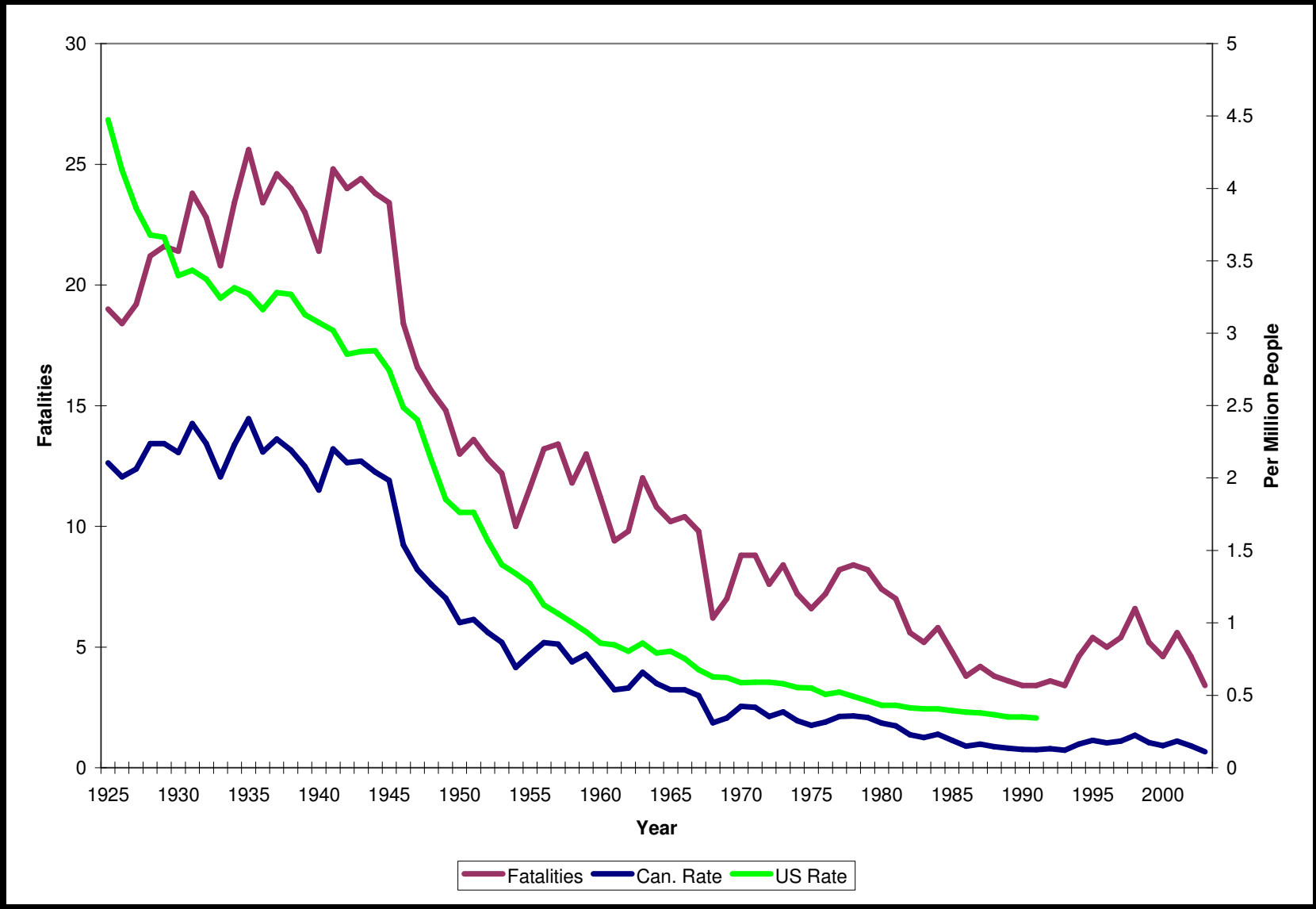
Lightning Deaths in Canada, 1921-2003



Environment Canada Environnement Canada

Source: Statistics Canada, vital statistics

Five-year moving average of Canadian lightning deaths and Canadian and U.S. mortality rates, 1921-2003



Source: Statistics Canada, vital statistics; U.S. rates based on Lopez and Holle, 1998:3

Environment Canada Environnement Canada

Distribution of Canadian Fatalities by Province

	1921-99*		1994-99		2004	
	Fatalities	% of total	Fatalities	% of total	Population (thousands)	% of total
British Columbia	16	1.7	0	0.0	4,201.9	13.2
Alberta	107	11.6	5	13.5	3,204.8	10.0
Saskatchewan	133	14.4	2	5.4	994.3	3.1
Manitoba	78	8.5	2	5.4	1,170.2	3.7
Ontario	316	34.2	17	46.0	12,407.3	38.8
Quebec	206	22.3	10	27.0	7,547.7	23.6
New Brunswick	39	4.2	1	2.7	752.1	2.4
Prince Edward Island	2	0.2	0	0.0	137.9	0.4
Nova Scotia	24	2.6	0	0.0	937.5	2.9
Newfoundland and Labrador	2	0.2	0	0.0	517.3	1.6
Nunavut, Northwest, and Yukon Territories	0	0.0	0	0.0	103.5	0.3
CANADA	**923**	**100.0****	**37**	**100.0****	**31,974.4**	**100.0****

*excludes 1959-64, 2000-present period where provincial breakdown was unavailable
**numbers may not add to 100 due to rounding

Environment Canada Environnement Canada

Source: Statistics Canada, vital statistics

Canadian Institute for Health Information (CIHI)
Lightning-related Injuries

Fiscal Year	NTR Hospital Admissions (cases)*	NACRS Emergency Room Visitation (Ontario only)**
1999	33	n/a
2000	30	n/a
2001	7	n/a
2002	16	59
2003	12	52
Annual Average	**20.0**	**55.5**

*does not include those who later died in-hospital

**does not include those received in ER and later admitted to hospital

Council of Canadian Fire Marshals and Fire Commissioners (CCFMFC)
Injuries Associated with Lightning-ignited Fires

	Fires ignited by lightning	% of all fires	Deaths	% of all fire deaths	Injuries	% of all fire injuries
1986	469	0.69	3	0.54	16	0.41
1987	595	0.89	1	0.19	17	0.44
1988	437	0.62	3	0.60	14	0.39
1989	563	0.84	6	1.20	29	0.77
1990	1125	1.67	2	0.43	18	0.48
1991	1194	1.75	0	0.00	19	0.55
1992	816	1.25	2	0.52	19	0.49
1993	574	0.87	3	0.72	24	0.69
1994	956	1.43	4	1.06	19	0.54
1995	2428	3.78	13	3.25	23	0.65
1996	408	0.68	3	0.80	7	0.22
1997	1157	2.06	2	0.48	25	0.79
1998	412	0.72	0	0.00	9	0.33
1999	362	0.66	4	1.03	2	0.09
2000	361	0.67	1	0.31	2	0.08
2001	387	0.70	0	0.00	4	0.17
TOTAL	**12244**	**1.21**	**47**	**0.70**	**247**	**0.47**

Analysis of Canadian Media Reports

- ***Review applications of technique for other hazards***

  Hazard events (Hewitt and Burton, 1971; Jones, 1993; Charlton et al., 1995; Ibsen and Brunsden, 1996; Downton et al., 2005; Tarhule, 2005)

  Frequency/return periods (Cutter et al., 2000; Downton et al., 2005; Schuster et al., 2005)

  Damage trends (Dore, 2003; PSEPC;NOAA)

- ***Identify searchable newspaper archives***

  Factiva; Toronto Star Group; Canada's Community Newspaper Association, Ontario Community Newspaper Association, and Quebec Community Newspaper Association)—460 in total

- ***Develop keyword search protocol***

- ***Search for articles and develop report database***

  Casualty characteristics (i.e., age, gender), location (city and province), prevailing activity (e.g., golfing, camping, working), and extent of injury

Article Title: Lightning strikes Nfld. family three times

Source: Edmonton Journal | Auth

Date of Articl: Thursday, December 01, 2005 | Date of Strike: | Time of St

Location Information

Location - Provinc: Newfoundland | Location - City/Regio: St. John's

Death(s)

Deaths1 - Ag: 0 | Deaths1 - Sex: | Deaths1 - Activit: | Deatl

Deaths2 - Ag: 0 | Deaths2 - Sex: | Deaths2 - Activit: | Deatl

Injuries

1: Type: | Numbe: 0 | Ages: | # of Male: 0 | # of Female: 0 | Activit:

2: Type: | Numbe: 0 | Ages: | # of Male: 0 | # of Female: 0 | Activit:

3: Type: | Numbe: 0 | Ages: | # of Male: 0 | # of Female: 0 | Activit:

Property Damage

(•) Property Damag | Cause of Damage: Lightning | Type of D:

House(s) Damaged (#: 1 | House(s) Destroyed (#: 0 | Damage Cost ($): $3,000.00

Power Disrupted (peopl: | Power Disrupted (households:

People Evacuate: | Forest Fire Costs ($): $0.00 | Forest Fire Period (year?:

Article Title: Pasture fire spreading: Had grown to 4,000 hectares by Thursday

Source: Daily Herald (Prince Albert) | Auth

Date of Articl: Friday, June 20, 2003 | Date of Strike: | Time of St

Location Information

Location - Provinc: Saskatchewan | Location - City/Regio: Prince Albert

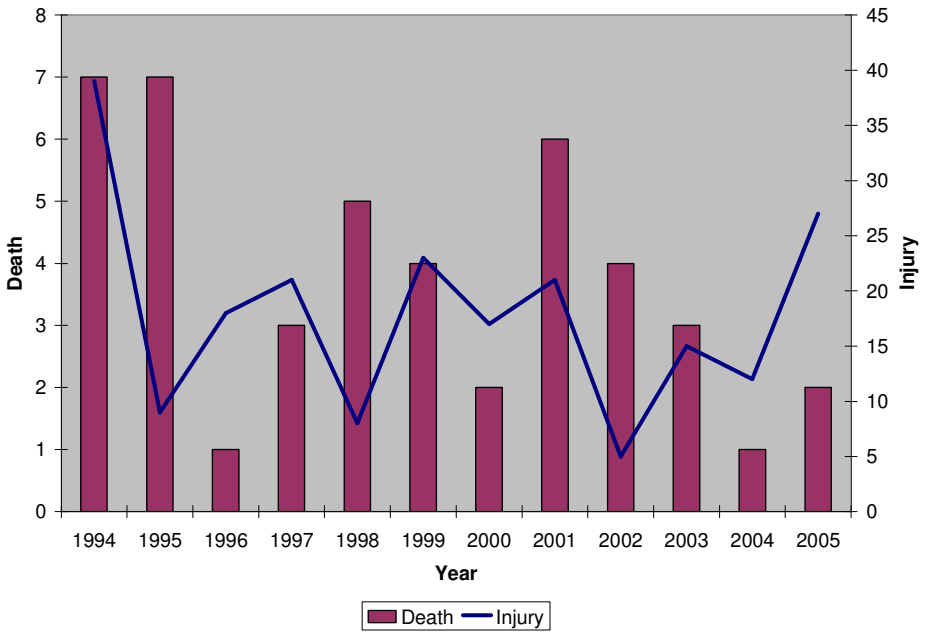
Death(s)

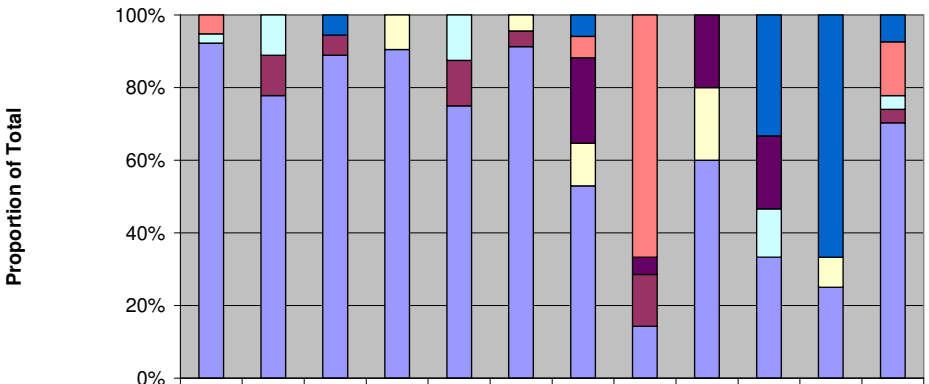
Deaths1 - Ag: 0 | Deaths1 - Sex: | Deaths1 - Activit: | Deatl

Deaths2 - Ag: 0 | Deaths2 - Sex: | Deaths2 - Activit: | Deatl

Injuries

Analysis of Canadian Media Reports





	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Nova Scotia			1				1			5	8	2
Quebec	2						1	14				4
Saskatchewan							4	1	1	3		
Mantoba	1	1			1					2		1
British Columbia				2		1	2		1		1	
Alberta		1	1		1	1		3				1
Ontario	36	7	16	19	6	21	9	3	3	5	3	19

Environment Canada Environnement Canada

Media Report Analysis: Temporal and Socio-demographic Factors

AGE	DEATHS		INJURIES	
	Count	Percentage of total*	Count	Percentage of total*
<16	6	11.3 (14.6)	12	4.3 (17.1)
16-30	10	18.9 (24.4)	21	7.6 (30.0)
31-45	11	20.8 (26.8)	22	7.9 (31.0)
46-60	8	15.1 (19.5)	10	3.6 (14.2)
> 60	6	11.3 (14.6)	5	1.8 (7.1)
Unknown	12	22.6	207	74.7
TOTAL	53	100.0**	277	100.0**

*numbers in parentheses refer to percentage of known deaths or injuries
**numbers may not add to 100 due to rounding

Media Report Analysis: Temporal and Socio-demographic Factors

MONTH	DEATHS			INJURIES		
	Count	% of total*	Per Incident	Count	% of total*	Per Incident
January	0	0	0	0	0	0
February	0	0	0	0	0	0
March	0	0	0	0	0	0
April	0	0	0	7	2.5	2.3
May	2	3.8	1.0	17	6.1	1.7
June	17	32.1	1.3	58	20.9	2.5
July	18	34.0	1.1	108	39.0	3.0
August	15	28.3	1.0	76	27.4	2.7
September	1	1.9	1.0	6	2.2	1.5
October	0	0	0	5	1.8	2.5
November	0	0	0	0	0	0
December	0	0	0	0	0	0
TOTAL	**53**	**100.0***		**277**	**100.0***	

*numbers may not add to 100 due to rounding

Media Report Analysis: Temporal and Socio-demographic Factors

DAY	DEATHS			INJURIES		
	Count	% of total*	Per Incident	Count	% of total*	Per Incident
Sunday	5	9.4	1.0	14	5.1	1.6
Monday	5	9.4	1.7	29	10.5	2.1
Tuesday	8	15.1	1.3	27	9.7	1.9
Wednesday	6	11.3	1.0	12	4.3	1.0
Thursday	9	17.0	1.3	64	23.1	4.9
Friday	6	11.3	1.0	74	26.7	3.2
Saturday	14	26.4	1.2	57	20.6	2.7
TOTAL	**53**	**100.0**		**277**	**100.0**	

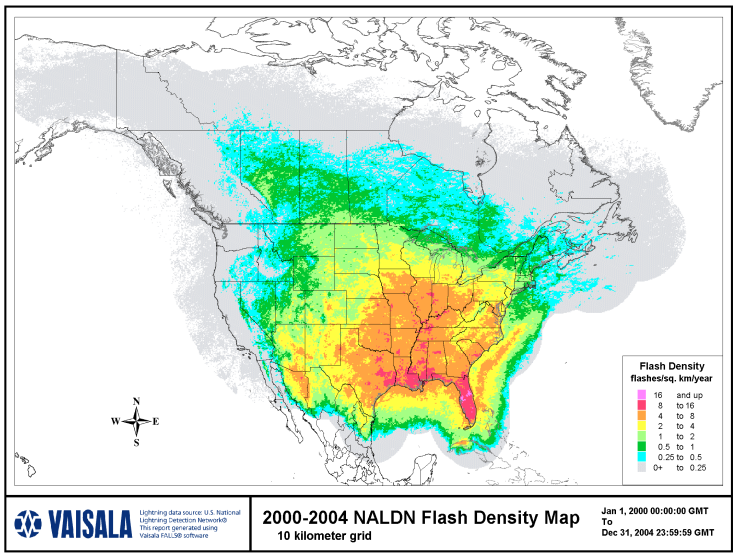
Media Report Analysis: Temporal and Socio-demographic Factors

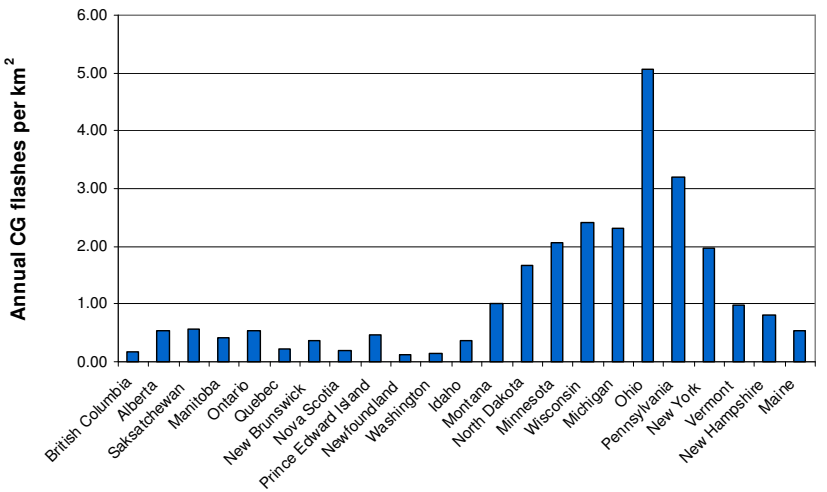
ACTIVITY	DEATHS			INJURIES		
	Count	% of total*	Per Incident	Count	% of total*	Per Incident
Golf	4	7.5 (8.3)	1.0	29	10.5 (11.3)	1.9
Camp/Hike	11	20.8 (22.9)	1.1	47	17.0 (18.4)	3.6
Picnic	5	9.4 (10.4)	1.7	11	4.0 (4.3)	2.2
Boating	8	15.1 (16.7)	1.1	18	6.5 (7.0)	1.6
Soccer	1	1.9 (2.1)	1.0	11	4.0 (4.3)	11.0
Baseball	1	1.9 (2.1)	1.0	28	10.1 (10.9)	9.3
Other Sport**	4	7.5 (8.3)	1.0	15	5.4 (5.9)	2.5
Work	3	5.7 (6.3)	1.0	41	14.8 (16.0)	2.3
In Home	4	7.5 (8.3)	2.0	24	8.7 (9.4)	1.6
In Shelter	1	1.9 (2.1)	1.0	7	2.5 (2.7)	3.5
Other	6	11.3 (12.5)	1.0	25	9.0 (9.8)	1.8
Unknown	5	9.4	1.0	21	7.6	1.8
TOTAL	53	100.0*		277	100.0*	

*numbers in parentheses refer to percentage of known deaths or injuries; numbers may not add to 100 due to rounding
**other sport includes cycling, equestrian, tennis

Analysis and Transfer of U.S. Lightning Mortality and Morbidity Statistics

PROVINCE/STATE	Fatality rate (per million population)	Injury rate (per million population)
BRITISH COLUMBIA	0.04	0.08
Washington	0.03	0.28
Idaho	0.39	1.68
Montana	0.56	1.85
ALBERTA	0.08	0.14
Montana	0.56	1.85
SASKATCHEWAN	0.17	0.66
Montana	0.56	1.85
North Dakota	0.13	1.04
MANITOBA	0.22	0.36
North Dakota	0.13	1.04
Minnesota	0.12	1.16
ONTARIO	0.17	0.80
Minnesota	0.12	1.16
Wisconsin	0.14	1.75
Michigan	0.11	1.06
Ohio	0.20	1.07
Pennsylvania	0.15	1.53
New York	0.05	0.90
QUEBEC	0.03	0.24
New York	0.05	0.90
Vermont	0.41	0.69
New Hampshire	0.07	5.15
Maine	0.20	4.37
NEW BRUNSWICK	0.00	0.00
NOVA SCOTIA	0.18	1.25
PRINCE EDWARD ISLAND	0.00	0.00
NEWFOUNDLAND & LABRADOR	0.00	0.00
Maine	0.20	4.37





Analysis and Transfer of U.S. Lightning Mortality and Morbidity Statistics

PROVINCE/STATE	Adjusted fatality rate range*	Adjusted injury rate range*
British Columbia	0.04-0.18	0.08-0.79
Alberta	0.08-0.31	0.14-1.03
Saskatchewan	0.05-0.32	0.36-1.07
Manitoba	0.02-0.22	0.23-0.36
Ontario	0.01-0.17	0.11-0.80
Quebec	0.01-0.09	0.10-1.81
New Brunswick	0.00-0.14	0.00-2.96
Nova Scotia	0.08-0.18	1.25-1.65
Prince Edward Island	0.00-0.17	0.00-3.67
Newfoundland & Labrador	0.00-0.05	0.00-1.01

*Original US and Canadian casualty rates based on 1994-2005 data (Table 11)

Estimates of average annual lightning fatalities from vital statistics (3.4) and the media analysis (3.8) based on 1999-2003 data fall squarely between the broad estimate of 1-5 deaths per year suggested by the transfer of U.S. casualty rates to Canadian provinces

The Composite Picture: Lightning-related Mortality

	Media-based	*Vital statistics*	**Maximum**	**CCFMFC fire statistics**	**TOTAL**	**RATE (per million population)**
1994	7	11	11	4	**15**	0.52
1995	7	6	7	13	**20**	0.68
1996	1	3	3	3	**6**	0.20
1997	3	6	6	2	**8**	0.27
1998	5	7	7	0	**7**	0.23
1999	4	4	4	4	**8**	0.26
2000	2	3	3	1	**4**	0.13
2001	6	8	8	0	**8**	0.26
AVERAGE	4.4	6.0	6.1	3.4	9.5	0.32

The Composite Picture: Lightning-related Injuries

	Media-based	CIHI NTR (hospital admissions)	CIHI NACR (Ontario emergency room visitation)	CCFMFC Fire statistics
1994	39	-	-	19
1995	9	-	-	23
1996	18	-	-	7
1997	21	-	-	25
1998	8	-	-	9
1999	23	33	-	2
2000	17	30	-	2
2001	21	7	-	4
2002	5	16	59	-
2003	15	12	52	-
1994-2003 average	17.6	n/a	n/a	n/a
1994-2001 average	19.5	n/a	n/a	11.4
1999-2003 average	16.2	20.0	n/a	n/a
2002-2003 average	10.0	14.0	55.5	n/a

Underreporting

LOW estimate: 14.0 + 55.5*(low national inflation factor) = 92 injuries/yr

HIGH estimate: 14.0 + 55.5*(high national inflation factor) + 11.4 = 164 injuries/yr

Caveats/Discussion

- ***Difficulty associated with merging of disparate data sets***
- ***Considerable interannual and regional variability relative to number of deaths and injuries***
- ***Underreporting issues remain***

  Misclassification, indirect causes

- ***A better estimate…***

  Still small risks that are concentrated in space, time, and by socio-demographic profile (0.32 fatalities/3.3-5.2 injuries per million population

CAUSE	Mortality Rate (per 100,000 population)			
	2000	2001	2002	2003
All causes of death	615.5	600.8	598.2	586.9
Cancer	180.4	178.7	178.2	175.6
Heart disease	152.0	143.1	138.6	133.3
Diabetes mellitus	18.9	19.3	20.9	20.5
Suicide	11.1	11.1	11.2	11.3
Motor vehicle accidents	8.6	8.3	9.2	9.0
Falls	4.3	4.6	4.6	5.0
Homicide	1.6	1.5	1.5	1.5
HIV/AIDS	1.6	1.3	1.2	1.3
Influenza	1.5	0.2	0.6	0.5

Source: Statistics Canada (http://www40.statcan.ca/l01/cst01/health30a.htm)

Summary

- *About 9-10 lightning-related deaths and 92-164 injuries occur each year in Canada*
- *Lightning mortality has declined significantly over the past century*
- *The majority of lightning-related fatalities and injuries in Canada occur in Ontario. With the exception of B.C., the distribution of fatalities reflects current provincial population and CG lightning frequencies*
- *Most lightning-related fatalities and injuries occur during the June-August summer season. The Thursday-Saturday period accounted for almost 55% of all fatalities and over 70% of all injuries, most likely related to higher rates of participation in outdoor activities.*
- *Most victims are male, less than 45 years old, and engaged in outdoor recreational activities when injured or killed in a lightning incident*
- *Media reports used in the study were found to underestimate lightning mortality by 36% when compared to vital statistics. Morbidity was underreported by 20-600% relative to hospital statistics depending on the severity of injury included in the analysis.*

Summary

- *Fires ignited by lightning are important secondary sources of lightning-related casualties accounting for about 3 deaths and 15 injuries per year from 1986-2001*
- *Although the relative risks may be small compared to chronic disease, motor vehicle collisions, etc., exposure to lightning and thus the potential risk of injury is very discrete and concentrated in terms of vulnerable activities, locations and time. This concentration makes the lightning hazard more 'potent' than annualized per capita estimates might suggest and, more importantly, allows one to target public risk-reduction strategies, information and programs*

Recommendations/Next Steps

- *Results from this study should replace current estimates of lightning fatalities and injuries used by Environment Canada and other federal departmental in various communications with the public and other stakeholders*
- *EC should consider further development of the media report database to support CLDN operations and further research, including*
- *In terms of continued research:*

  Study should be expanded as planned to investigate the social and economic impacts associated with lightning-related property damage and service interruptions using a combination of data derived from media reports and sector-specific records.

  Further analysis of injury and fatalities at the storm level to discern additional finer-scaled risk patterns or associations between lightning and exposure

  Major focus in both sets of studies should be on evaluation of risk or damage prevention measures, particularly those that relate to expanded or enriched use of the CLDN data by both public and private sector clients.

Environment Canada Environnement Canada