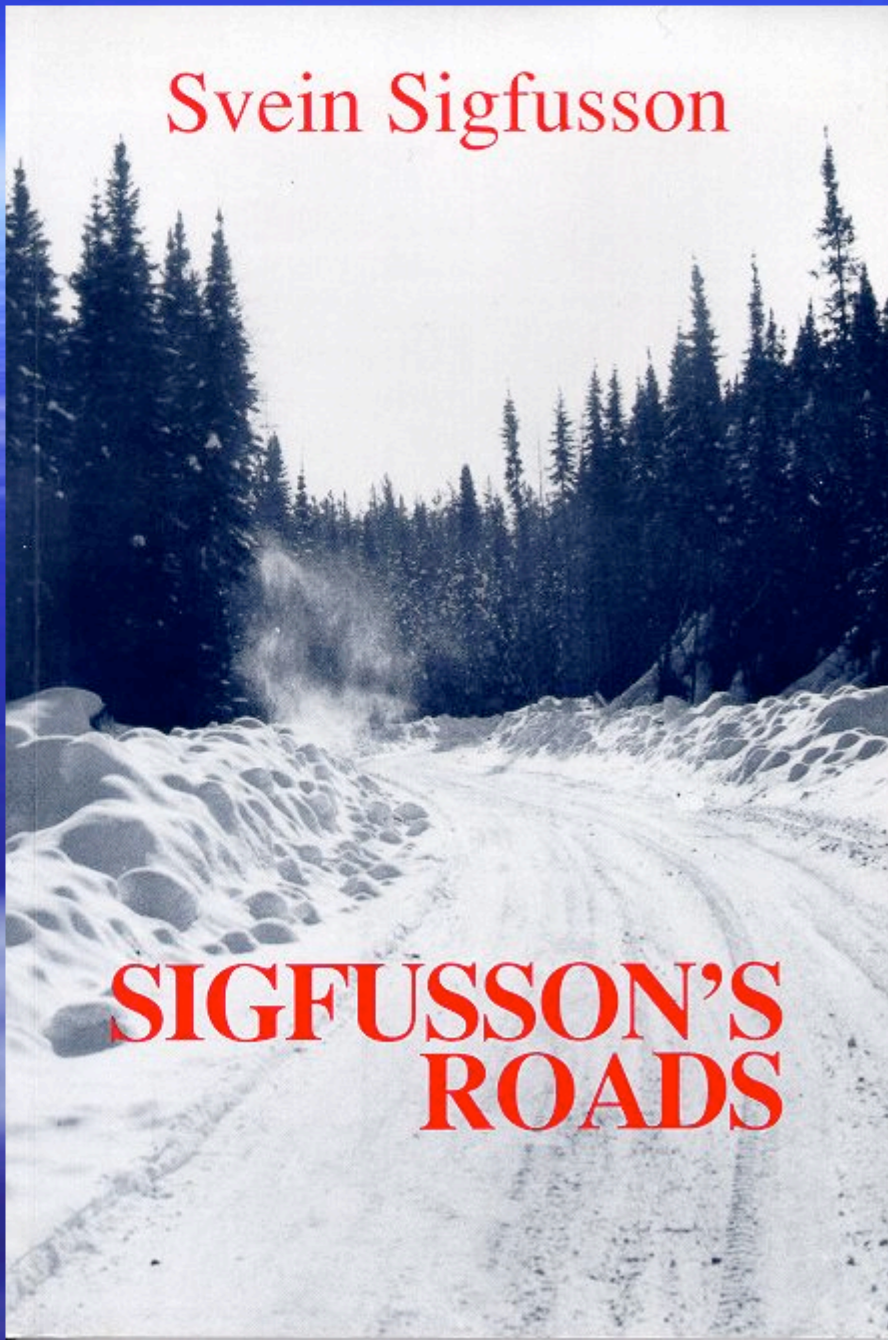
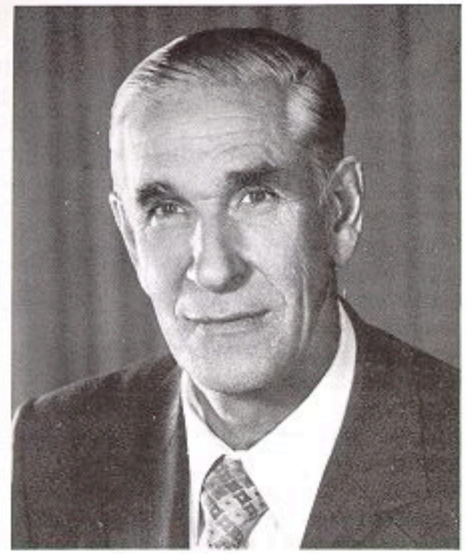
Climate Change and Effect
Seasonal Transportation
to
Remote Communities
in
Manitoba

Manitoba
Transportation &
Government Services

History

The Origins of the Winter Roads





Svein Sigfusson C.M.

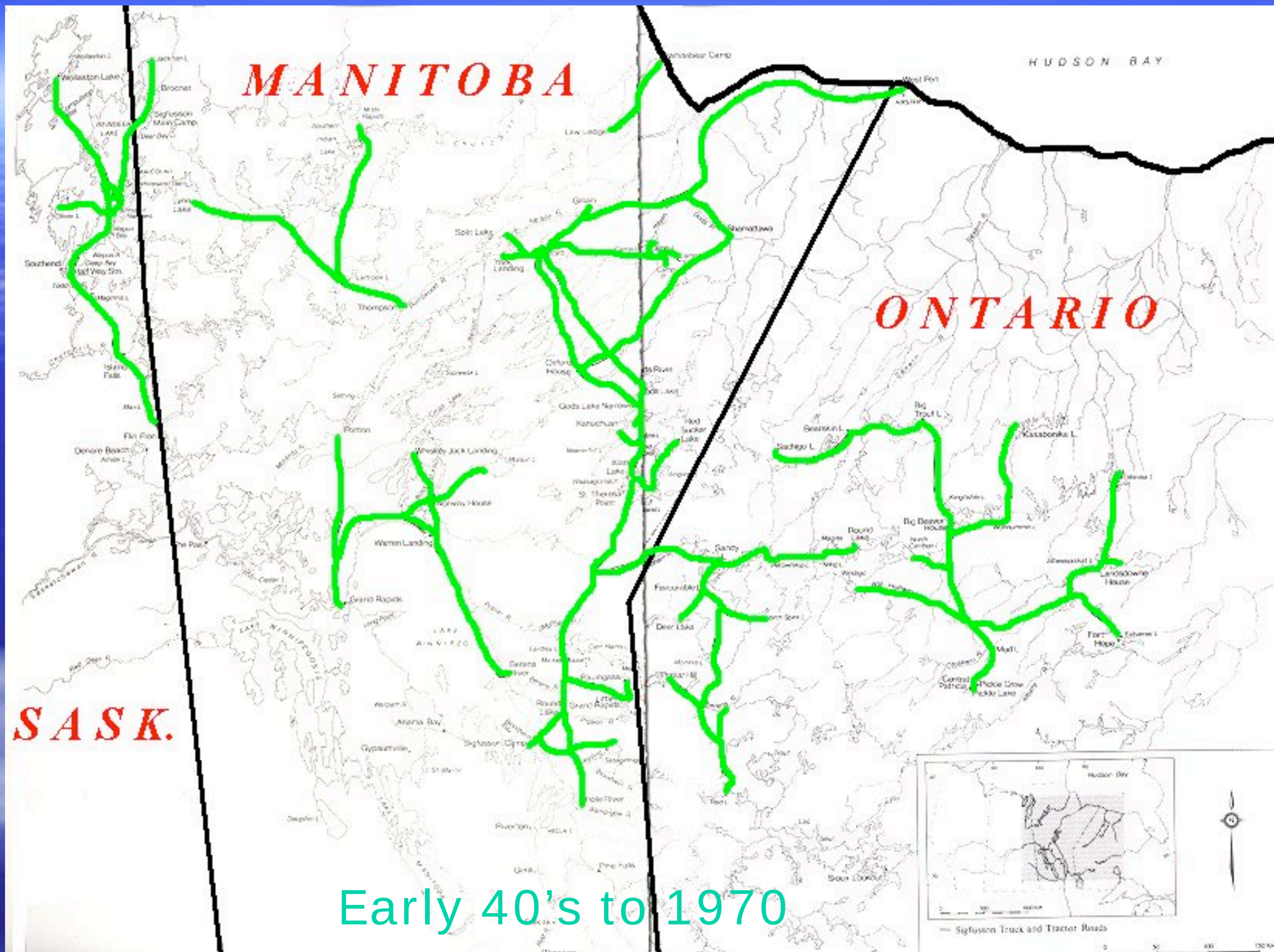
Svein Sigfusson was born 15 July 1912 at Lundar, Manitoba. During the Depression years Svein and his brothers managed the family farm; in the winters they fished Lake Manitoba.

In 1941 Mr Sigfusson went north to look into developing a fishing industry at Reindeer Lake. From this beginning he moved into freighting by tractor train, and over the next thirty-three years he developed a road system extending 3,560 miles across the northern regions of Saskatchewan, Manitoba and Ontario.

As a Canadian athlete, Svein Sigfusson won his first gold medal for the hammer throw in 1938 at the Canadian Championship Games in Saskatoon. Over the next sixteen years he earned eight Manitoba championships and nine Canadian championships in the hammer and discus throws. In 1950 at the British Empire Games in Auckland, New Zealand he was awarded the bronze medal for the discus throw. In 1982 he was inducted into the Manitoba Sports Hall of Fame.

In 1974 Mr Sigfusson was invested as a Companion to the Order of Canada.

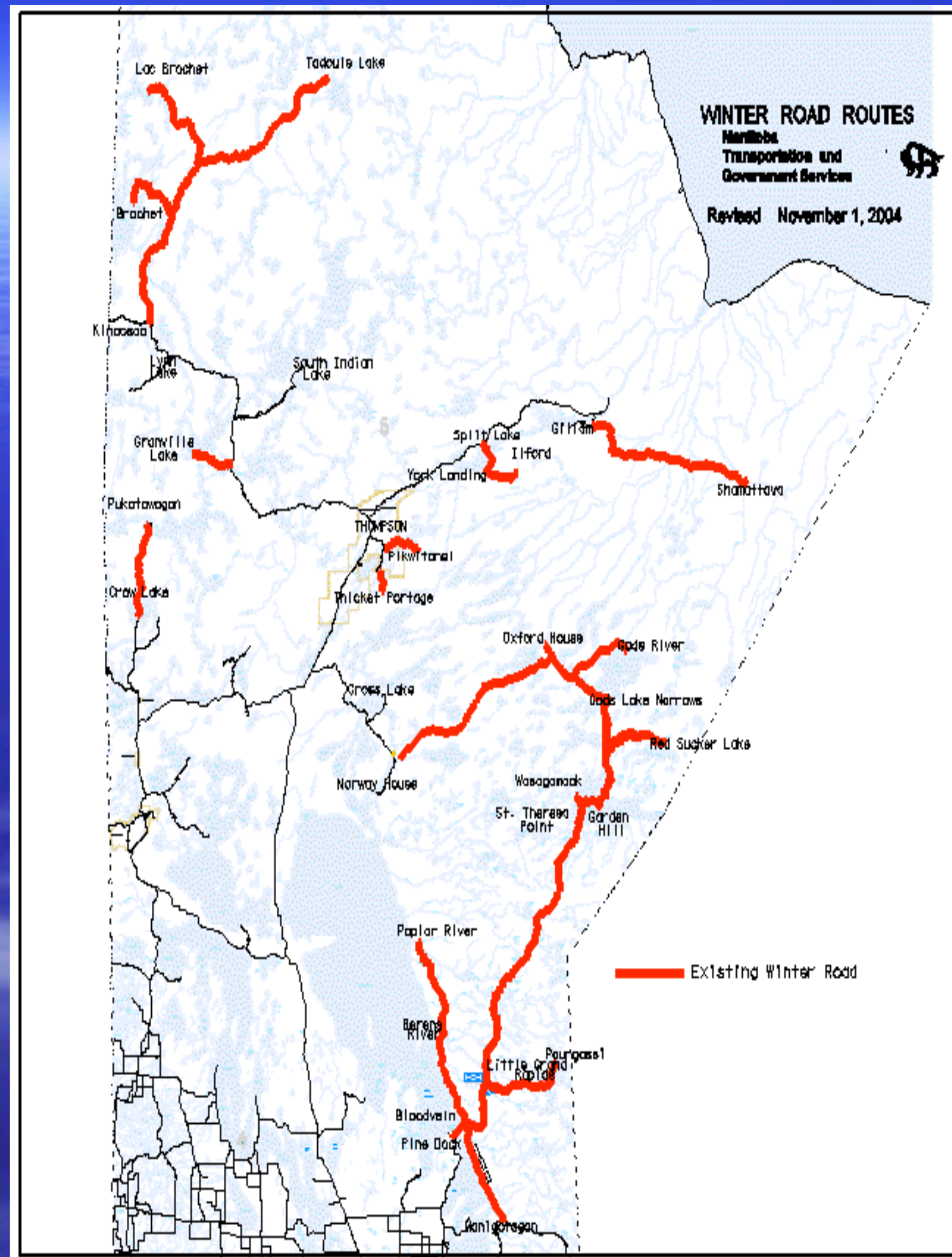
Svein Sigfusson married Thelma Goodman of Lundar in 1941. They have two sons and three daughters.


MANITOBA
ONTARIO
SASK.
HUDSON BAY
Early 40's to 1970

The Winter Roads Today

Manitoba's Winter Roads

- Communities
- People
- Roadway Significance
- Contractors



A Changing Climate

The Effect

on

Winter Roads

GEOSIGN

Ice melting

Arctic sea ice coverage >>>>>>>>>>>>>>

Shrinking sea ice An image based on satellite data shows perennial ice cover in 1979, when the ice extended over the Arctic Ocean from edge to edge. Since then the area of coverage has decreased by 9 percent per decade.

A similar image from 2003 shows dramatically reduced perennial ice cover. Large areas of open ocean have appeared near Russia, Alaska, and Canada. Some climate models project that the ice will be gone in summer by the end of this century.

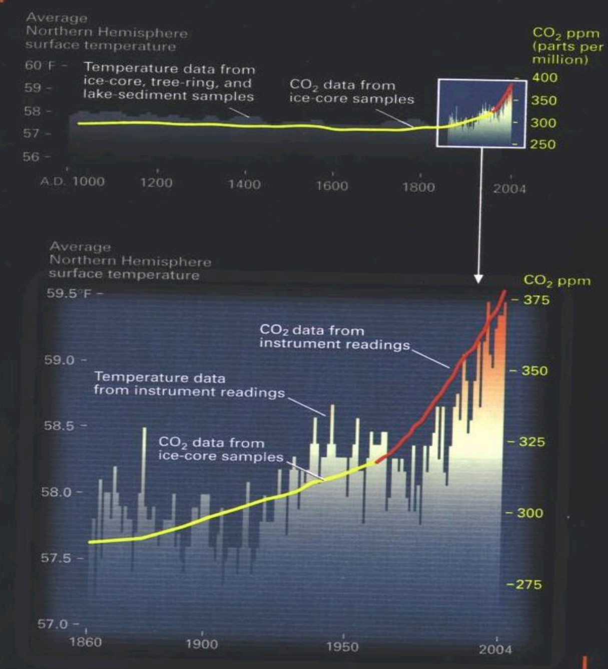
National Geographic Excerpt – Sept 2004

GEOSIGN

Temperature rising

Temperature and CO_2 records >>>>>>>

Warming trends
The concentration of carbon dioxide in the atmosphere helps determine Earth's surface temperature. Both CO_2 and temperature have risen sharply since 1950.



Over the past 140 years, forest clearing and fossil-fuel burning have pushed up the atmosphere's CO_2 level by nearly 100 parts per million. The average surface temperature of the Northern Hemisphere has mirrored the rise in CO_2. The 1990s was the warmest decade since the mid-1800s, and 1998 the warmest year.

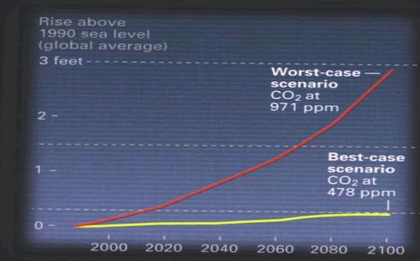
One Degree of Change

GEOSIGN

Sea level rising

Sea level change projections >>>>>>>>>>>>

Coasts threatened
As ice melts and warmer seawater expands, the oceans will rise. How much depends largely on how much CO_2 and other greenhouse gases we continue to emit. This model projects rises of between a few inches and a few feet over the next century.



In Bangladesh, at just over 3 feet of rise, 70 million people could be displaced.

75 percent of coastal Louisiana wetlands would be destroyed at just over 1.5 feet.

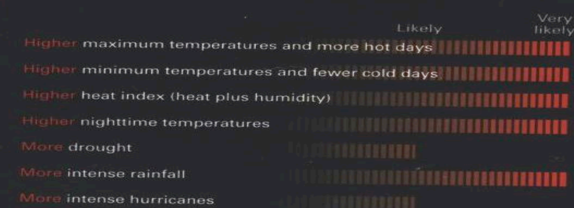
Many low-lying South Sea islands are at further risk of flooding at about 4 inches.

GEOSIGN

Weather turning wild?

Projected weather and climate changes >>>>>>>>

Storm warnings
Higher global temperatures could fuel extreme weather. At right are computer-model projections of the chance that various weather events will be more frequent in a warmer world.



ART BY 5W INFOGRAPHIC, JUAN VELASCO. TEMPERATURE DATA: MANN AND JONES, "GEOPHYSICAL RESEARCH LETTERS," VOL. 30, NO. 15 (FAR LEFT, TOP); PHIL JONES, CLIMATIC RESEARCH UNIT, UNIVERSITY OF EAST ANGLIA, U.K. (FAR LEFT, BOTTOM). CO_2 DATA: ETHERIDGE ET AL., COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANISATION, AUSTRALIA, AND AUSTRALIAN ANTARCTIC DIVISION (FAR LEFT, TOP); C. D. KEELING, SCRIPPS INSTITUTION OF OCEANOGRAPHY (FAR LEFT, BOTTOM). ARCTIC SEA ICE DATA (MIDDLE, TOP AND BOTTOM): J. COMISO, NASA. PROJECTED SEA LEVEL CHANGE SCENARIOS (ABOVE, TOP): INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE (IPCC). WEATHER PROJECTIONS (ABOVE, BOTTOM): IPCC. CO_2 PPM DATA (ABOVE): TOM WIGLEY, NATIONAL CENTER FOR ATMOSPHERIC RESEARCH

National Geographic Excerpt – Sept 2004

OBSERVED TRENDS IN THE WINTER THERMAL CLIMATE OF THE CANADIAN PRAIRIE PROVINCES, 1970-2005

Background

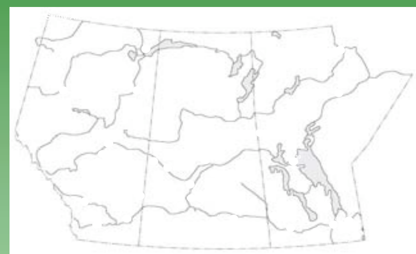
There is a very convincing body of evidence showing that the global climate is undergoing a period of warming that is, to a large degree, a result of enhanced radiative forcing produced by human activities[1,2]. Indeed, the global climate warmed by ~0.6°C during the 20th century, with substantial variation in the rate of change throughout this period. The last three and a half decades have exhibited an especially rapid rate of warming, at ~0.17°C/decade and ~0.19°C/decade in January[3]. Global Climate Models clearly indicate that this rate of warming is indicative of the global warming projected for the remainder of the 21st century. Of concern to a wide variety of stakeholders is the expectation that the Canadian prairie provinces will warm at a rate greater than the global average, especially in the winter. To compare recent climate change in the prairies with that observed for the globe as a whole, we here assess the observed rates of change in the winter thermal climate at climate stations in the three prairie provinces.

Methodology

Mean winter (December-January-February; DJF) maximum (DJFMAX) and minimum (DJFMIN) temperatures were calculated from raw daily values, and daily mean temperatures were used to calculate heating degree days below 0°C (DJFHDD-0), at 51 climate stations across the prairie provinces. Locations were chosen to produce a relatively representative geographic distribution (high-altitude Alberta stations were excluded), and stations were required to have at least 30 years of winter data during the 36-year study period (1970-2005). Station-winters with more than 16 days of missing daily data were excluded; 98.0% of the 1,836 (i.e., 51 x 36) possible station-winters had suitable data. In station-winters with 16 or fewer missing daily mean temperatures, DJFHDD-0 was pro-rated to the number of days in the winter; this was required in only 6.7% of the station-winters.

Linear regression analysis was applied to each of the DJFMAX, DJFMIN and DJFHDD-0 time series to determine the slopes of the best-fit lines; these slopes are reported as linear rates of change per decade. The statistical significance of the best-fit lines was assessed using a significance level of $\alpha = 0.05$. Furthermore, for each station, we calculated the correlation coefficient (r) between DJFHDD-0 and the number of winter days with minimum temperatures below -30°C (DJFMIN-30); for simplicity, the number of days with minimum temperatures below -30°C was pro-rated in station-winters with missing data. Winters are identified using the January-February year number; that is, the winter identified as 2005 consists of December 2004, January 2005 and February 2005.

Study Area



1 Arborg	14 Fort Chipewyan A	27 La Ronge A	40 Regina A
2 Beechy	15 Fort McMurray	28 Lethbridge A	41 Saskatoon A
3 Binscarth	16 Fort Saskatchewan	29 Lynn Lake A	42 Calmar
4 Brandon CDA	17 Gilbert Plains	30 Medicine Hat	43 Sprague
5 Butte St. Pierre	18 Gillam A	31 North Battleford A	44 Swift Current CDA
6 Calgary International A	19 Grand Rapids Hydro	32 Outlook PFRA	45 Thompson A
7 Camrose	20 Grande Prairie	33 Peace River A	46 Waseca
8 Churchill A	21 High Level A	34 Pierson	47 Weyburn
9 Cold Lake A	22 High River	35 Pilger	48 Winfield
10 Edmonton	23 Hodgson 2	36 Pinawa WNRE	49 Winnipeg International A
11 Empress	24 Indian Head CDA	37 Plum Coulee	50 Yellow Grass
12 Estevan A	25 Island Lake A	38 Prince Albert A	51 Yorkton A
13 Flin Flon	26 Kelliher	39 Red Deer A	

Results

Many of the 51 stations were found to have warmed significantly (at $\alpha = 0.05$) over the 36-year study period. Significant positive (warming) trends in DJFMAX and DJFMIN were found at 31 (61%) and 22 (43%) of the stations, respectively (Figures 2 & 3). Significant negative (warming) trends in DJFHDD-0 were found at 24 (47%) of the stations (Figure 4). Only one of the stations (High River, Alberta) was found to have trends indicative of cooling, but these trends were not statistically significant. For all 51 stations, the DJFMAX rates of change ranged from -0.16 to 1.25, with a mean of 0.88°C per decade (Figure 5); the DJFMIN rates of change ranged from -0.33 to 1.34, with a mean of 0.85°C per decade (Figure 6); and the DJFHDD-0 rates of change ranged from -106.28 to 24.27, with a mean of -77.49 heating degree days per decade (Figure 7). Strong positive correlations were found to exist between DJFHDD-0 and DJFMIN-30; these ranged from r = 0.74 to r = 0.96, with a mean of r = 0.87 (Figure 8).

Discussion

Winter across the prairie provinces has clearly warmed over the last few decades. Many of the 51 stations studied had significant rates of warming during 1970-2005, with increasing maximum and minimum temperatures, and decreasing accumulations of heating degree days. Only one of the 51 stations had any trends indicative of cooling; these trends were not statistically significant.

Figure 2: Rate of Change of Mean Winter Maximum Temperature at Select Prairie Stations, 1970-2005

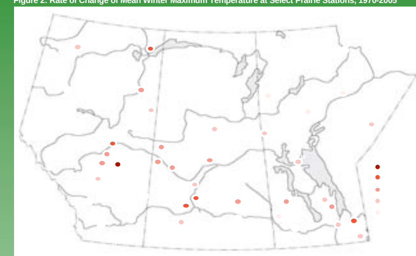


Figure 3: Rate of Change of Mean Winter Minimum Temperature at Select Prairie Stations, 1970-2005

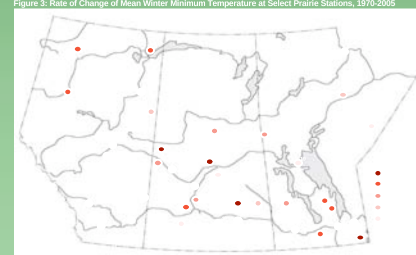


Figure 4: Rate of Change of Mean Winter Degree Days Below 0°C at Select Prairie Stations, 1970-2005

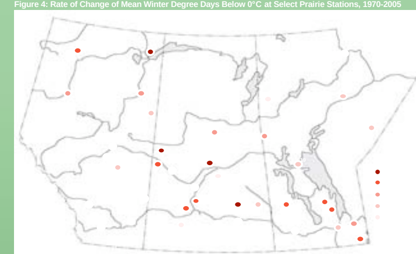


Figure 5: Frequency Distribution of Rates of Change of Mean Winter Maximum Temperature

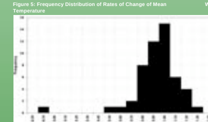


Figure 6: Frequency Distribution of Rates of Change of Mean Winter Minimum Temperature

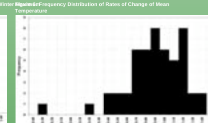


Figure 7: Frequency Distribution of Rates of Change of Mean Winter Heating Degree Days Below 0°C

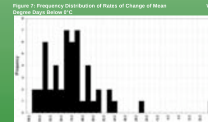
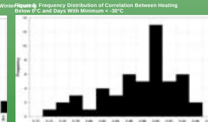
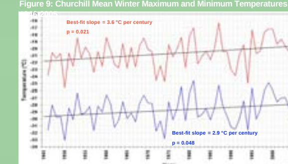


Figure 8: Frequency Distribution of Correlation Between Heating Degree Days Below 0°C and Days With Minimum < -30°C



The frequency of very cold winter days (with minimums below -30°C) has declined (results not shown) and was found to be highly correlated to the decreasing accumulations of heating degree days. Given the relatively short period of study, and the large amount of inter-annual variation in the climate of the region, it was not surprising to find that many of the observed trends were not statistically significant. Neither was it surprising to find that the rates of change in the mean maximum and minimum temperatures were found to be, on average, much greater than comparable global rates of change for the same period. Indeed, on average, the stations warmed at a rate about 4 times the global average. The spatial pattern of warming across the region is rather varied. However, it does appear that the parkland region warmed most significantly. Interestingly, Churchill, MB, was not found to have a significant warming trend, even though it is often used as an example of a place experiencing considerable climate change. However, one must keep in mind that climate change is a long-term process, not well represented by just a few decades of data. If we examine the winter temperature record for Churchill over the 60-year period of 1946-2005 we do see significant warming (Figure 9).

Figure 9: Churchill Mean Winter Maximum and Minimum Temperatures, 1946-2005



References & Notes

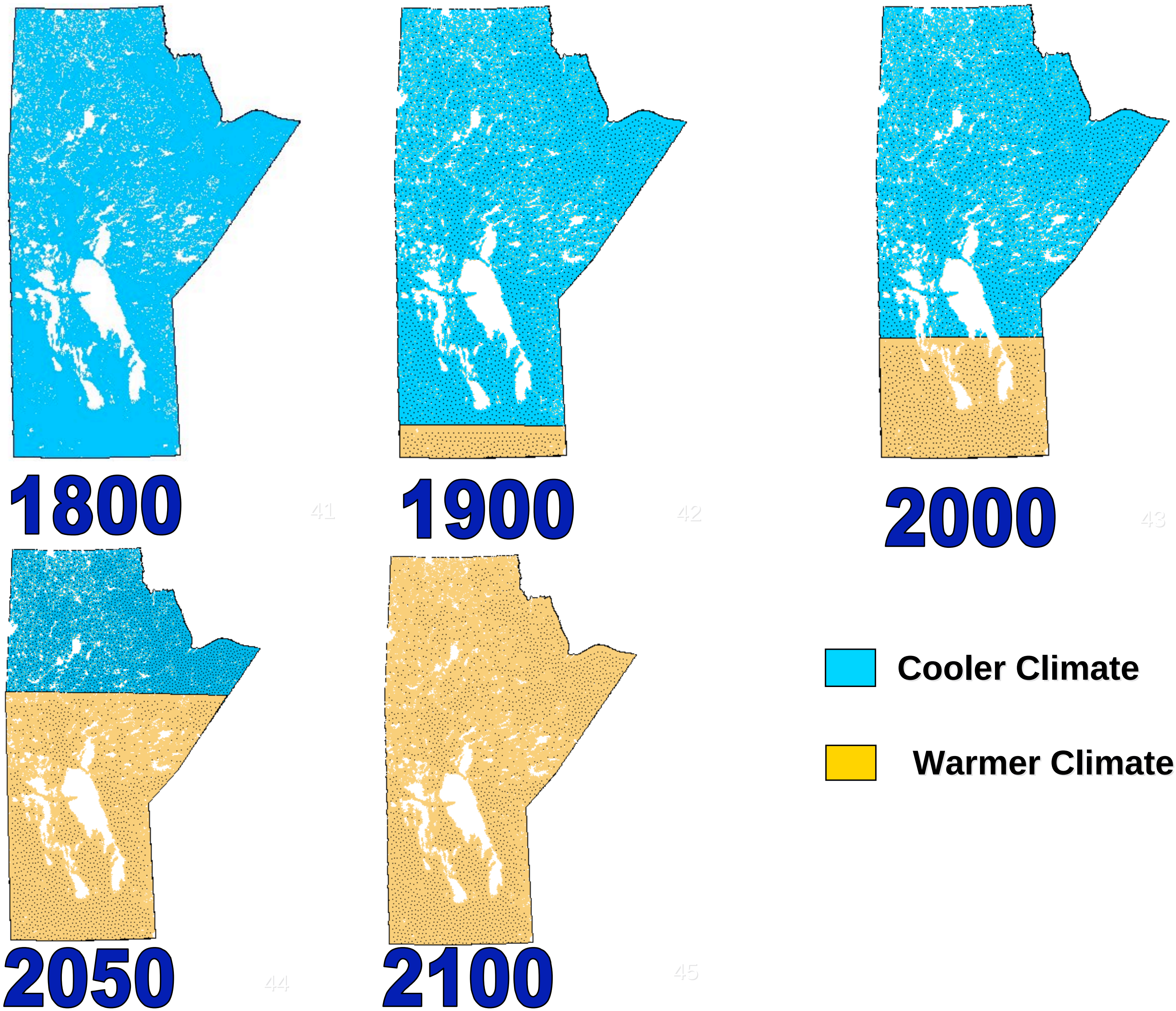
(1) *Climate Change 2001. Third Assessment Report of the Intergovernmental Panel on Climate Change* IPCC (WG I & II) (Cambridge Univ. Press, Cambridge, 2001); (2) Barnett, T. *et al.*. Penetration of human-induced warming into the world's oceans. *Science* 309(5732), 284-287 (2004); (3) For 1970-2004, the global surface (land & ocean) temperature increased at the rate of 0.173°C/decade; the January temperature (1970-2005) increased at the rate of 0.189°C/decade; data available from NOAA/NCDC at *www.ncdc.noaa.gov.*

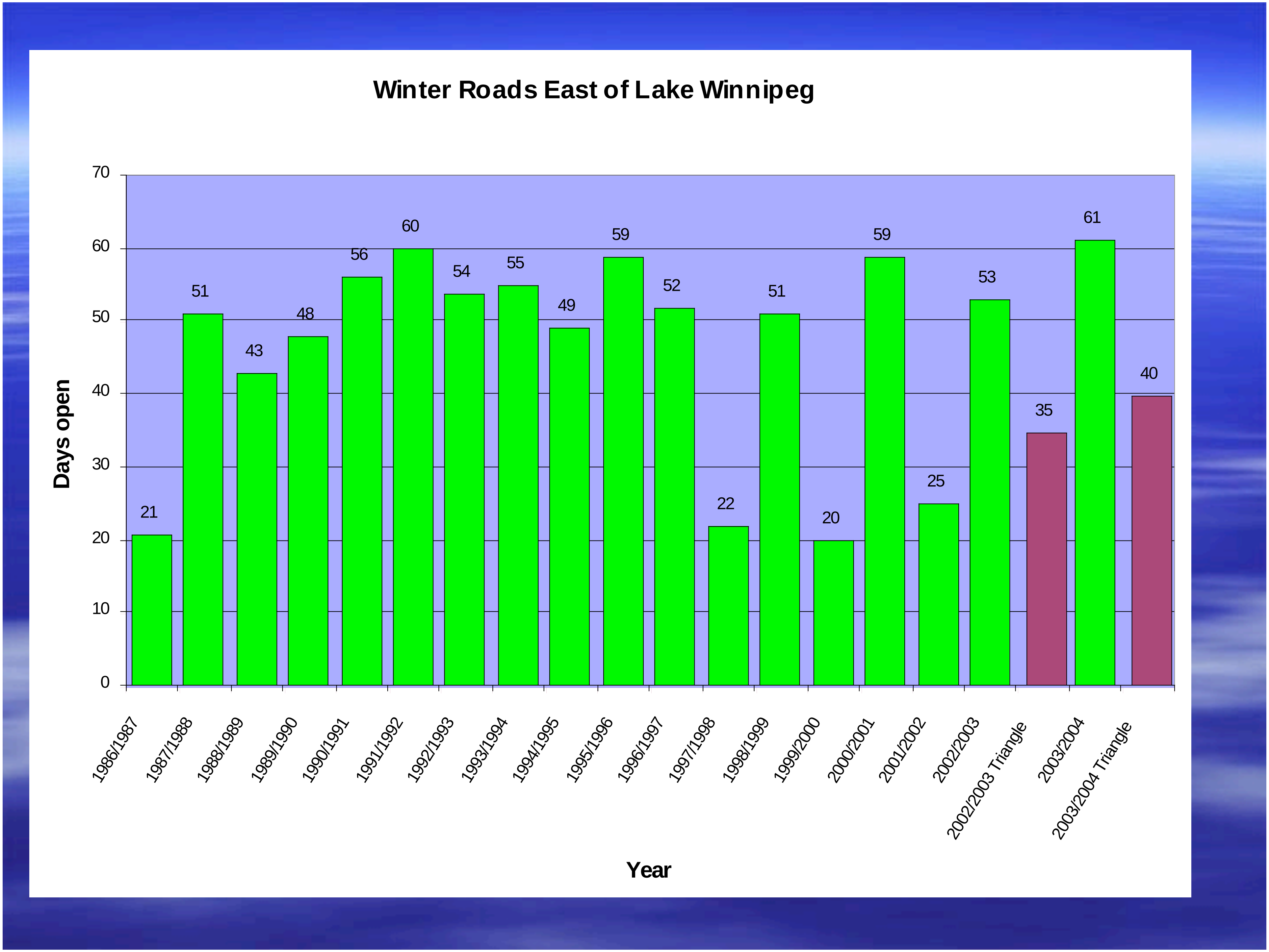
Acknowledgements

Financial support for this project was provided by the Prairie Adaptation Research Collaborative (PARC), Manitoba Hydro, Manitoba CareerFocus and The University of Winnipeg. Data was provided by Environment Canada.

Hastings, K.[1], Blair, D.[1], & Babb, J.[2]

[1] Dept. of Geography, University of Winnipeg, [2] Dept. of Mathematics & Statistics, University of Winnipeg


1800
1900
2000
2050
2100
Cooler Climate
Warmer Climate



Winter Roads East of Lake Winnipeg
Days open
Year
0
10
20
30
40
50
60
70
21
51
43
48
56
60
54
55
49
59
52
22
51
20
59
25
53
35
61
40
1986/1987
1987/1988
1988/1989
1989/1990
1990/1991
1991/1992
1992/1993
1993/1994
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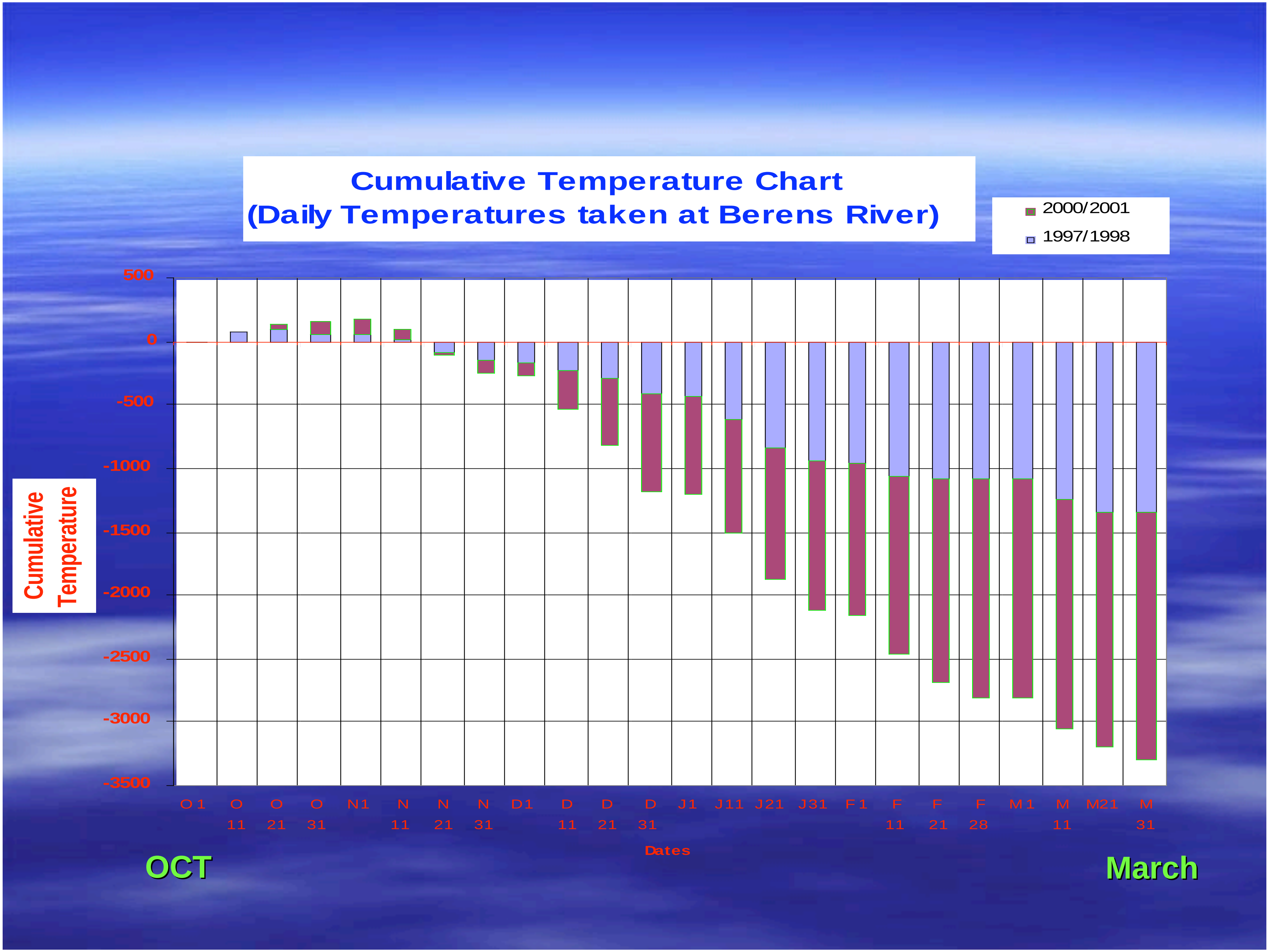
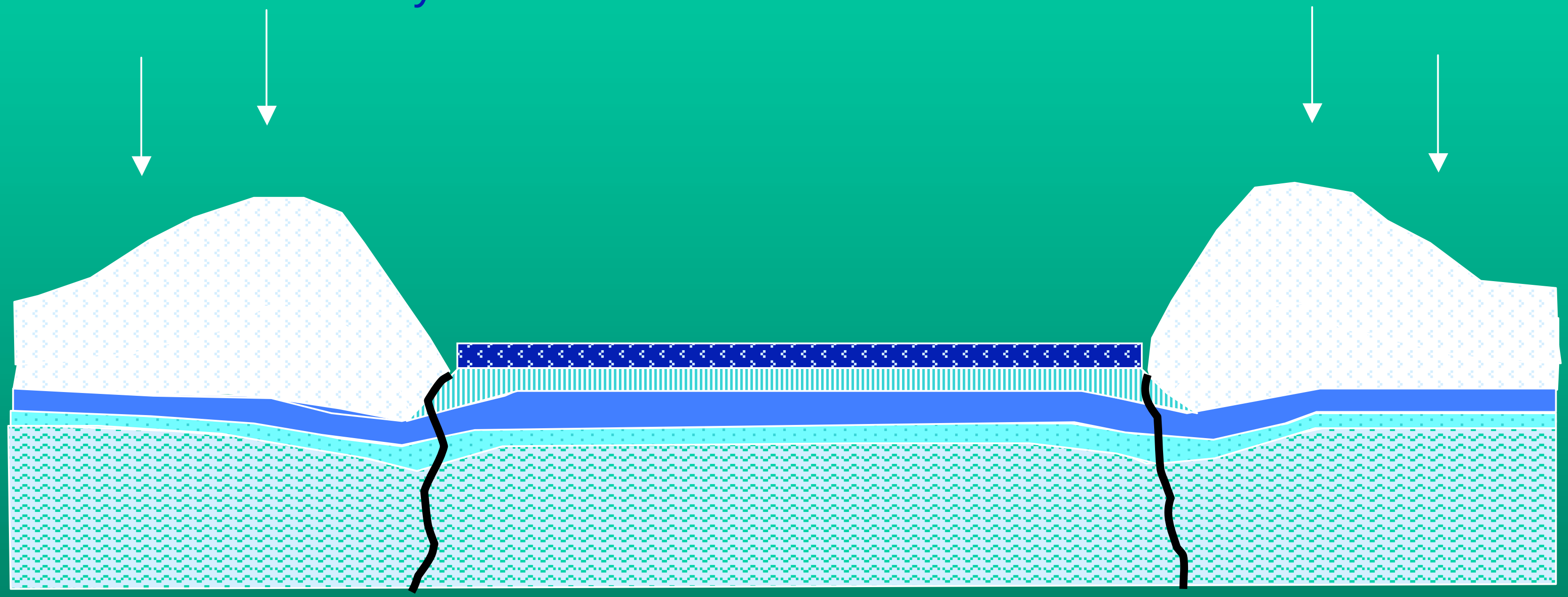
2002/2003 Triangle
2003/2004
2003/2004 Triangle



Cumulative Temperature Chart
(Daily Temperatures taken at Berens River)
2000/2001
1997/1998
Cumulative Temperature
500
0
-500
-1000
-1500
-2000
-2500
-3000
-3500
O 1
O 11
O 21
O 31
N 1
N 11
N 21
N 31
D 1
D 11
D 21
D 31
J 1
J 11
J 21
J 31
F 1
F 11
F 21
F 28
M 1
M 11
M 21
M 31
Dates
OCT
March

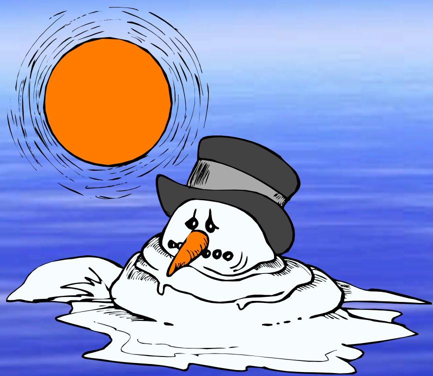
Bad Season Due to Weather Issues

- Warm November
- High Water Levels
- Heavy Snowfall



THIS IN TURN CAUSED THE ICE TO MOVE UPWARD CREATING CRACKS (UNSTABLE ICE)

This occurred in the Years of 2001/2002 ant 2002/2003



What If…

The Importance of Winter Roads

Airlift 1998


C46

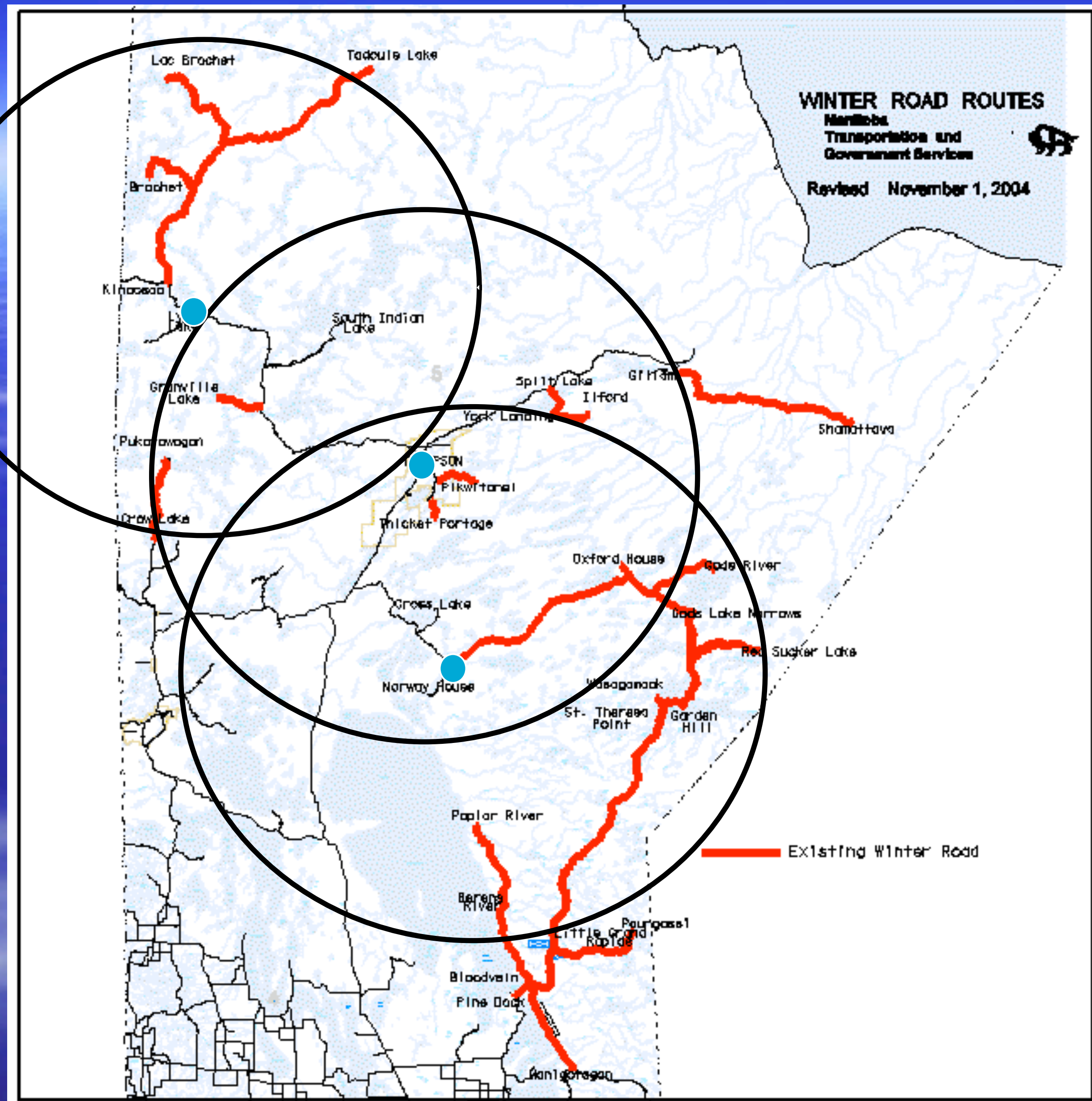

Fuel Farm


Bristol Freighter


DC 6

Airships,

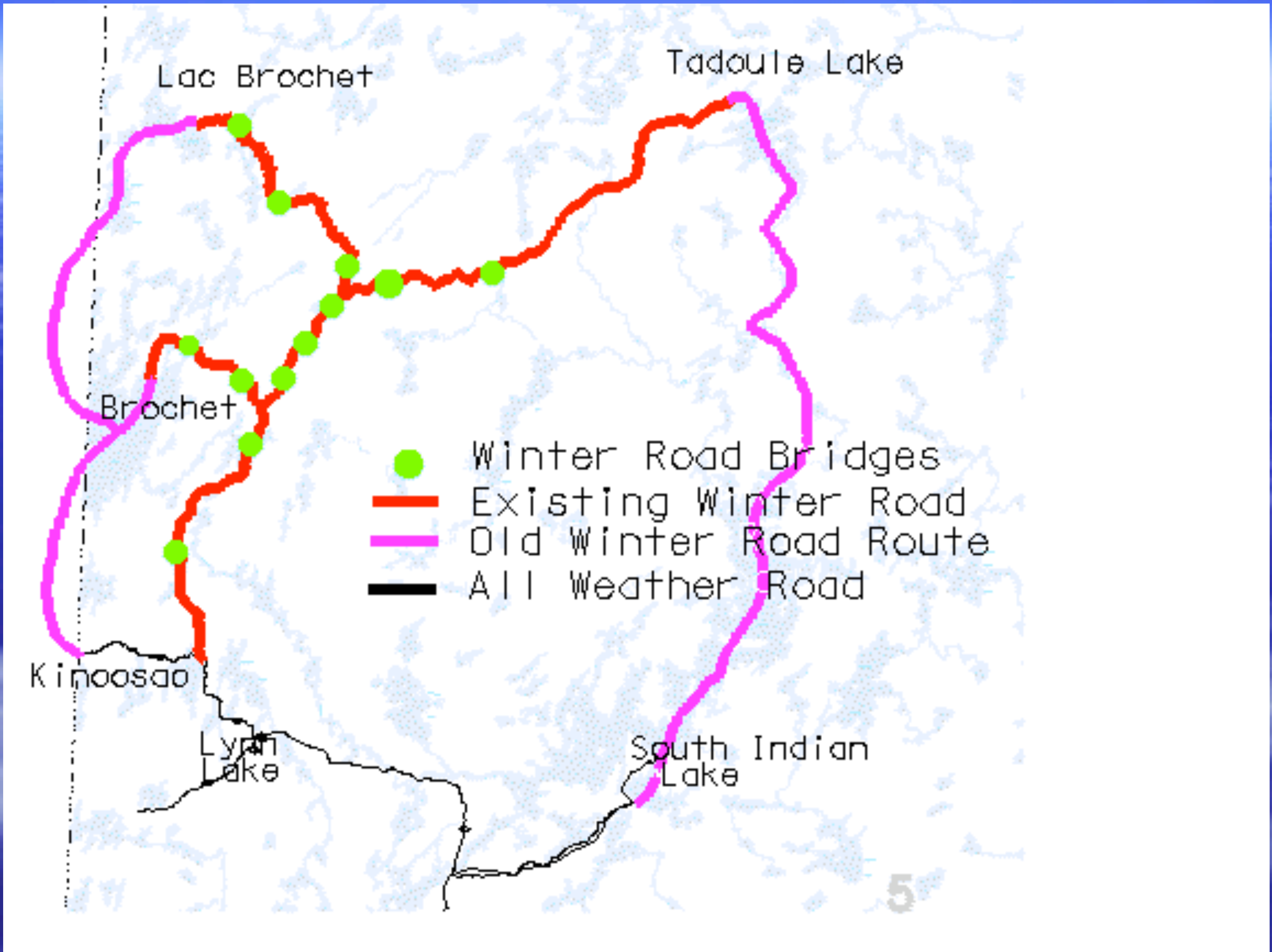
How could they help.....



Potential Airship Operational Sites

What is Being Done to Improve the Situation ?

Oxford House
Gods River
Cross Lake
Gods Lake Narrows
Red Sucker Lake
Norway House
Wasagamack
St. Theresa Point
Garden Hill
Winter Road Bridges
Existing Winter Road
Old Winter Road Route
All Weather Road
Potential Winter Roads
Poplar River
Berens River
Paungassi
Little Grand Rapids
Bloodvein
Pine Dock
Manigotagan


Lac Brochet
Tadoule Lake
Brochet
Kinoosao
Lynn Lake
South Indian Lake
Winter Road Bridges
Existing Winter Road
Old Winter Road Route
All Weather Road
5

What We Are Doing & What Else Can Be Done

Build Meccano or Acrow bridges instead of Ice bridges

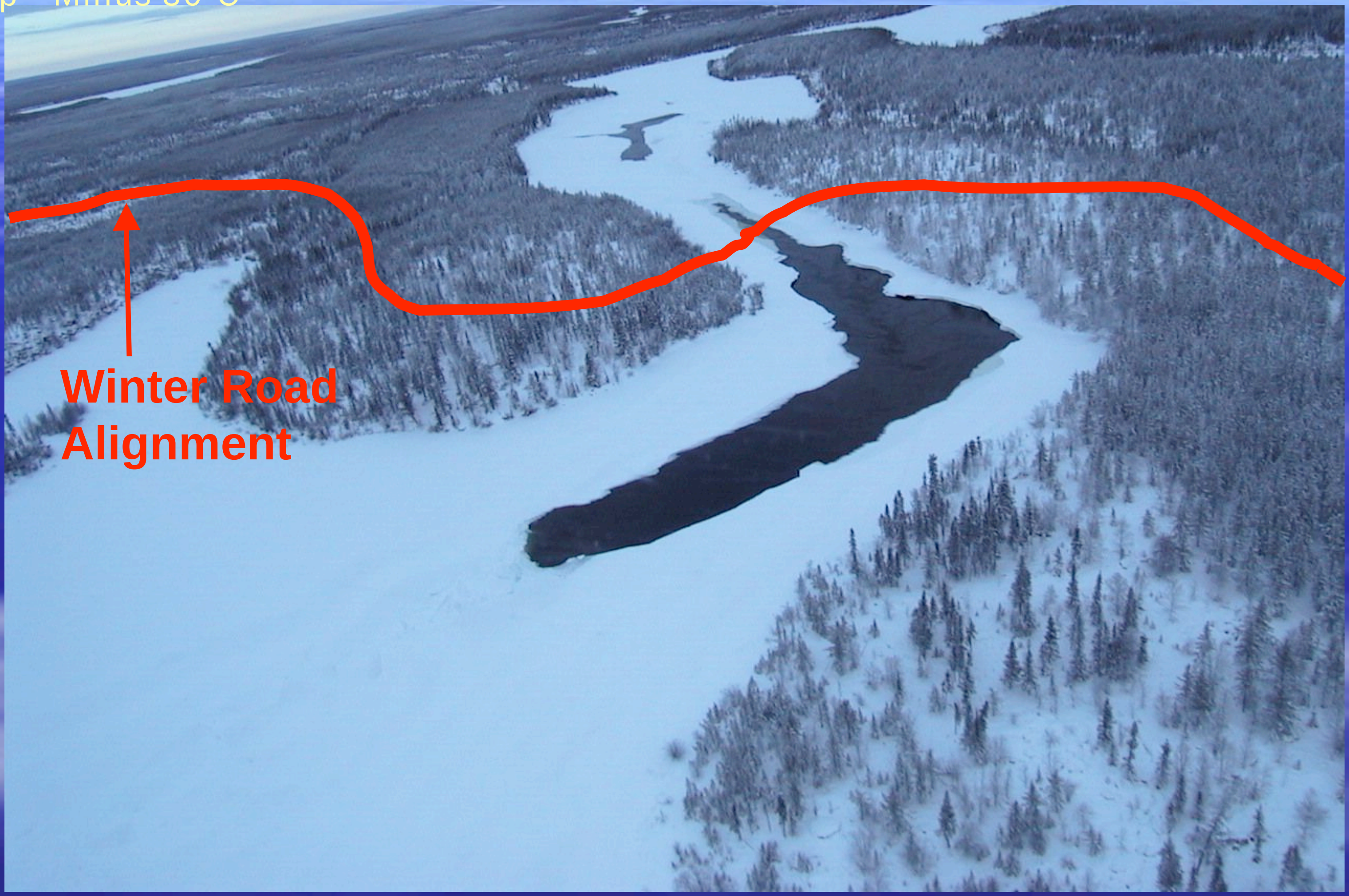

Stream Crossing


KOMATSU

Proposed Cochrane River – Acrow Bridge Site

February 2001

Temp - Minus 30^{o}C



Proposed Acrow Bridge Site at Gods River

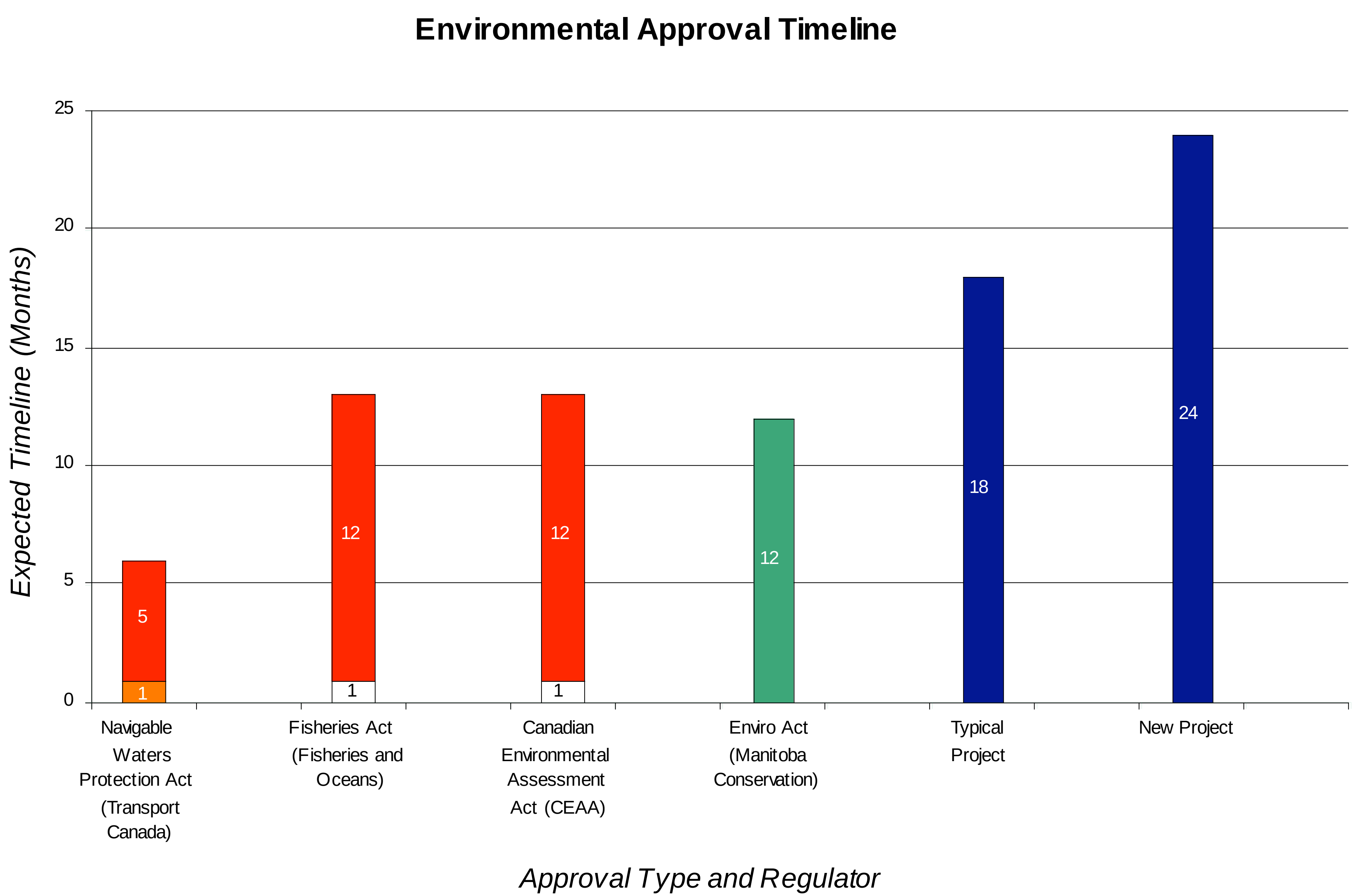
Cochrane River
Acrow Bridge

Hayes River Acrow Bridge

Gods River Acrow Bridge

Approvals, Permits & Licenses

- Environmental
  - DFO
  - Conservation
  - Navigable Waters
- TLE
- BCR
- Local Land Use


Environmental Approval Timeline
Expected Timeline (Months)
25
20
15
10
5
0
5
1
12
1
12
1
12
18
24
Navigable Waters Protection Act (Transport Canada)
Fisheries Act (Fisheries and Oceans)
Canadian Environmental Assessment Act (CEAA)
Enviro Act (Manitoba Conservation)
Typical Project
New Project
Approval Type and Regulator

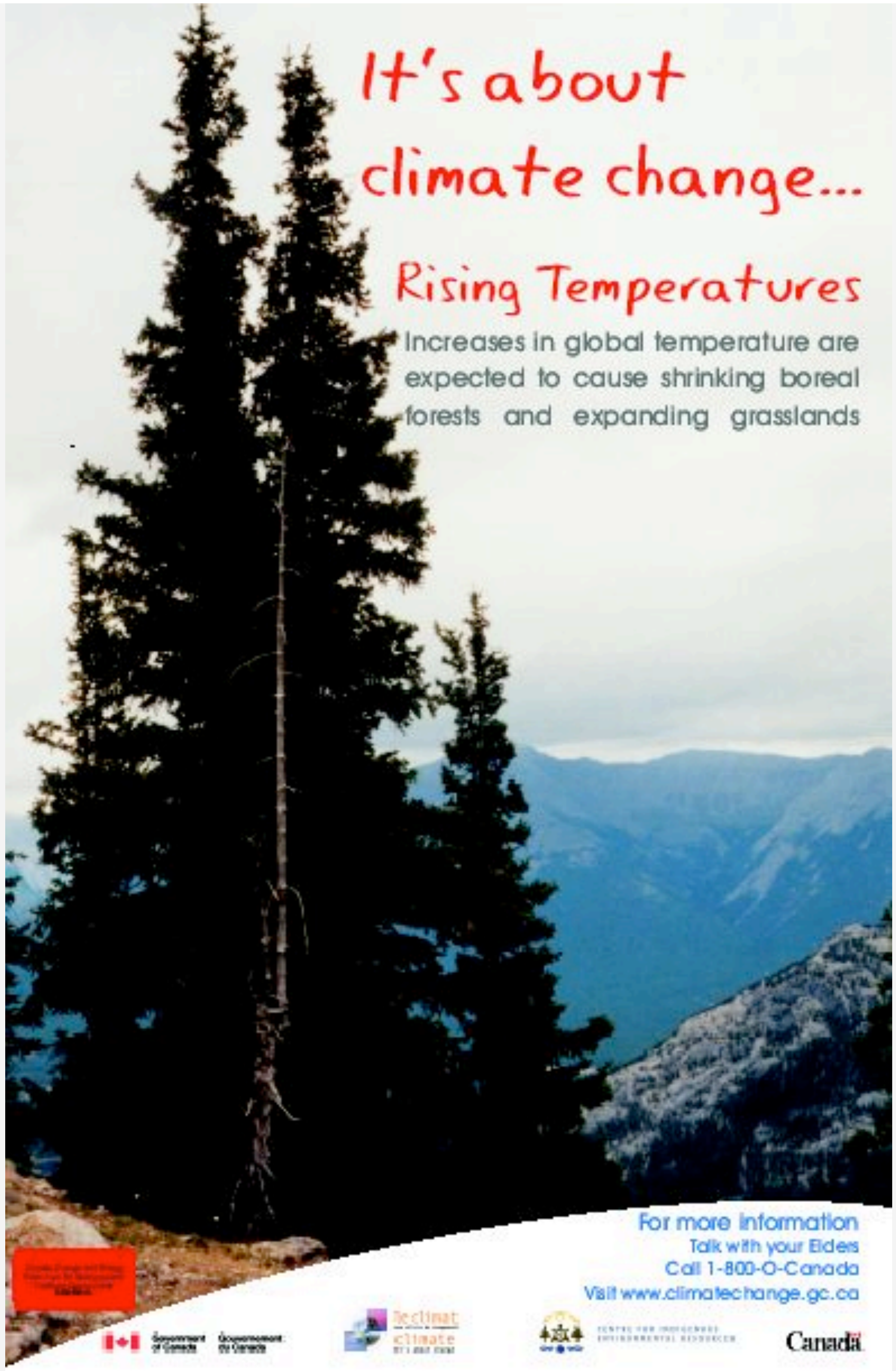
Negative Measures

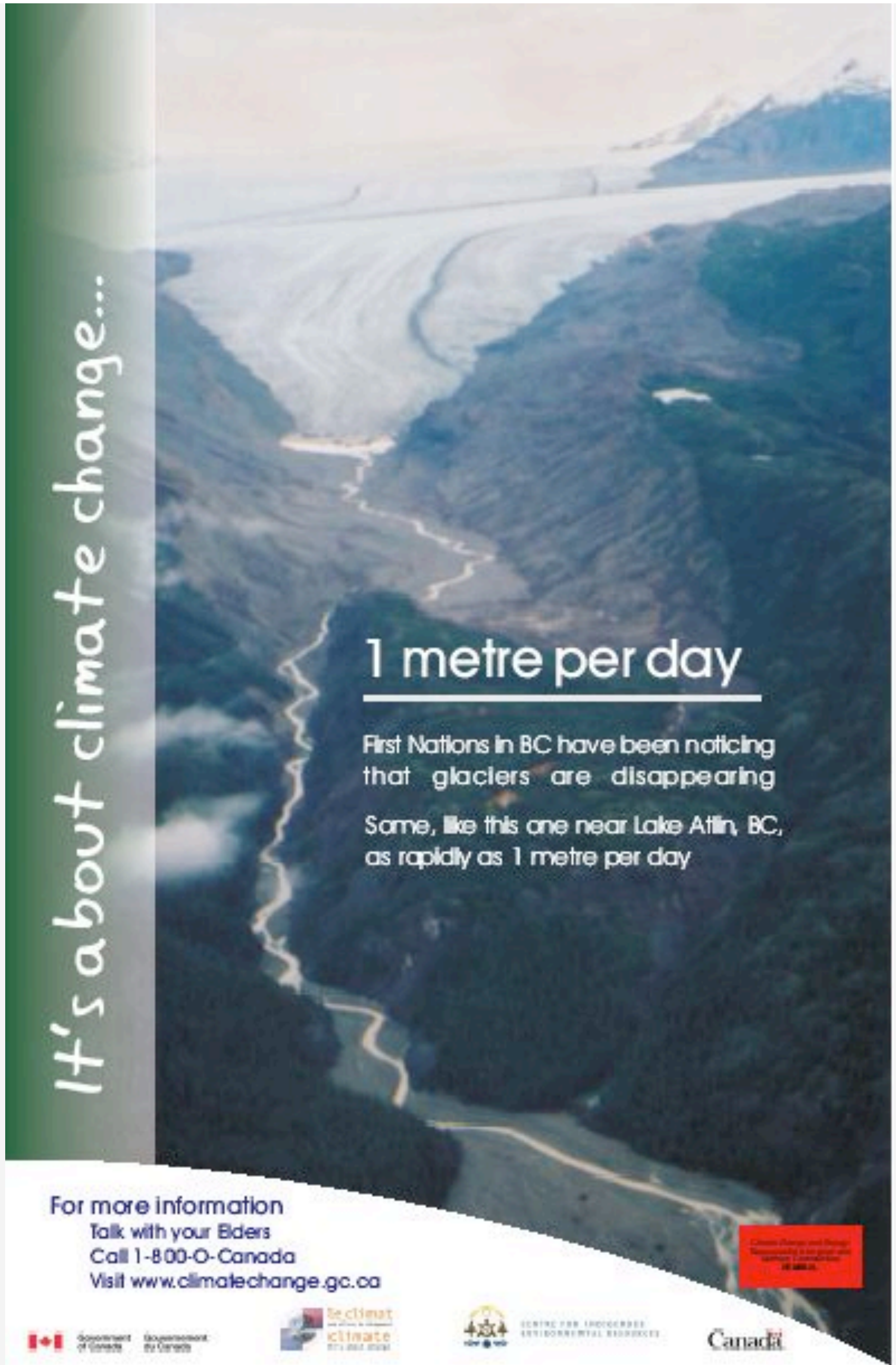
- Approval Process
- Political Holdbacks
- Delayed Timelines

- How do we over come the Negatives?

Positive Measures

- Improved Transportation Routes to Remote Communities
- Potential All Weather Based Land Routes
- Bridges
- Airships


It's about
climate change...
Rising Temperatures
Increases in global temperature are expected to cause shrinking boreal forests and expanding grasslands
For more information
Talk with your Elders
Call 1-800-O-Canada
Visit www.climatechange.gc.ca
Canada


It's about climate change...
1 metre per day
First Nations in BC have been noticing that glaciers are disappearing
Some, like this one near Lake Atlin, BC, as rapidly as 1 metre per day
For more information
Talk with your Elders
Call 1-800-O-Canada
Visit www.climatechange.gc.ca
Government of Canada
Gouvernement du Canada
le climat
climate
Centre for Indigenous Environmental Resources
Canada


It's time to
wake up....
Climate Change Affects
Us All.
For more information
Talk with your Elders
Call 1-800-O-Canada
Visit www.climagechange.gc.ca
Canada

The End

Questions ?