Climate Change In Canada Impacts and Policies

Meinhard Doelle
Dalhousie University Law School
Marine and Environmental Law Program

Car Crazy!

Presentation Overview

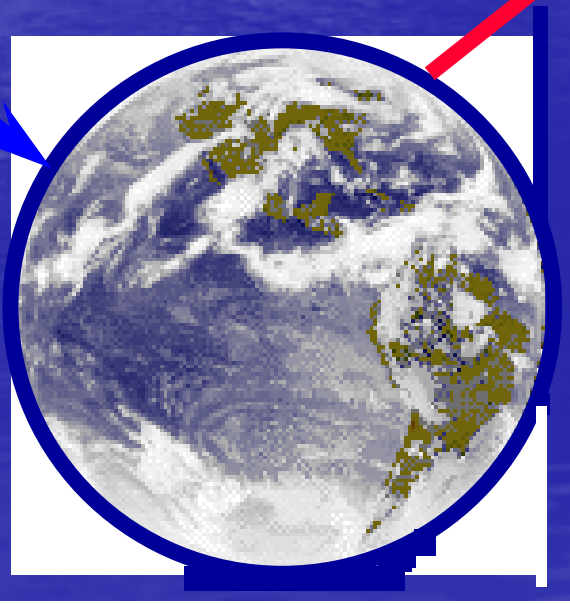
- Canadian Context
  - Climate Change Impacts In Canada
  - Sources of Emissions In Canada
  - Opportunities for Emission Reductions
  - Federal/Provincial Relations
- Canada's Position/Role Internationally
  - Sinks
  - Kyoto Mechanisms
  - Compliance
  - Long Term Issues (Dev Countries, US, Beyond 2012)
- Implementing Kyoto in Canada
- Conclusion

The Greenhouse Effect

Incoming Energy

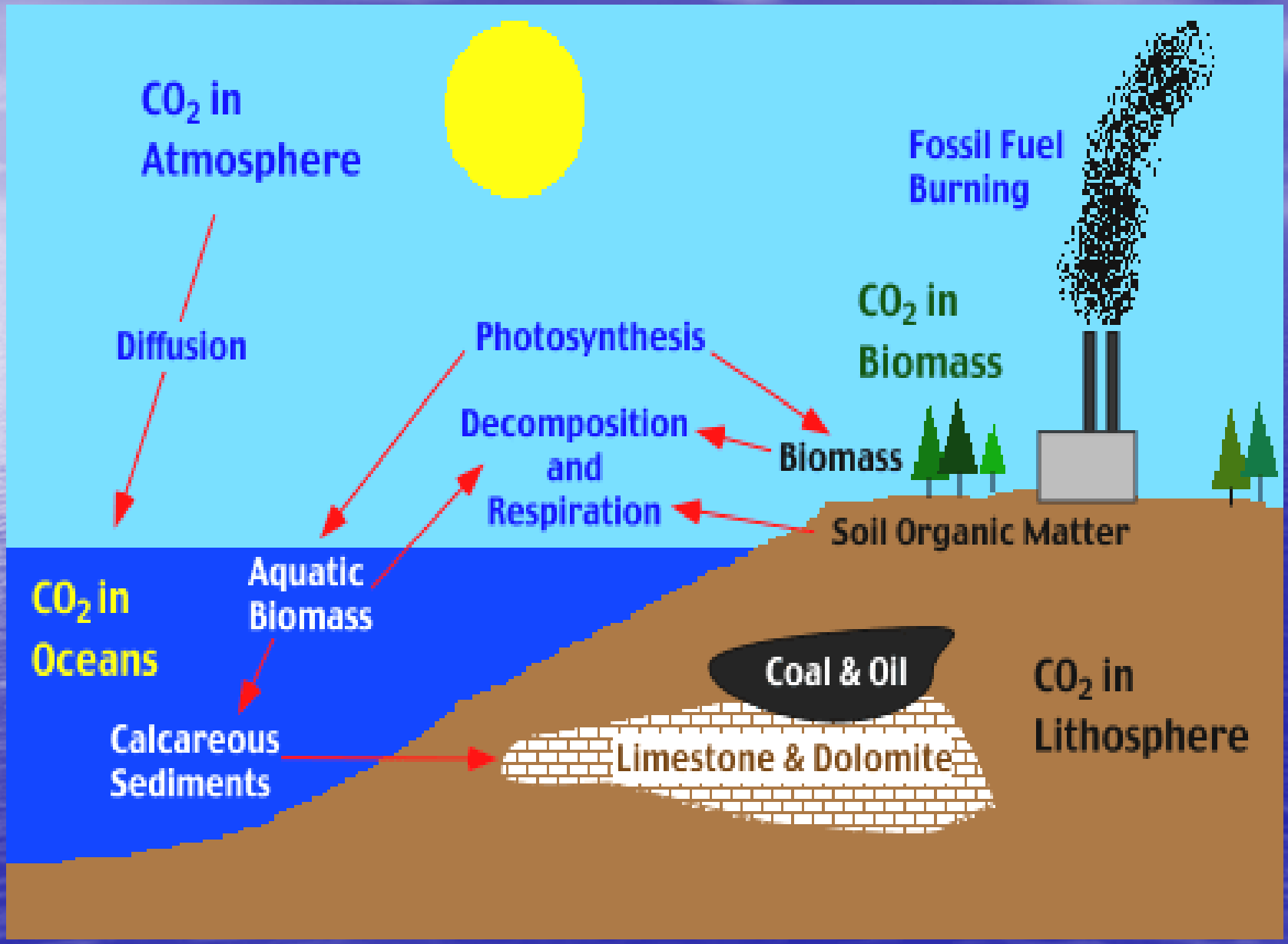
Reflected Energy

Outgoing Energy



Energy Trapped
By Greenhouse Gases

The Carbon Cycle



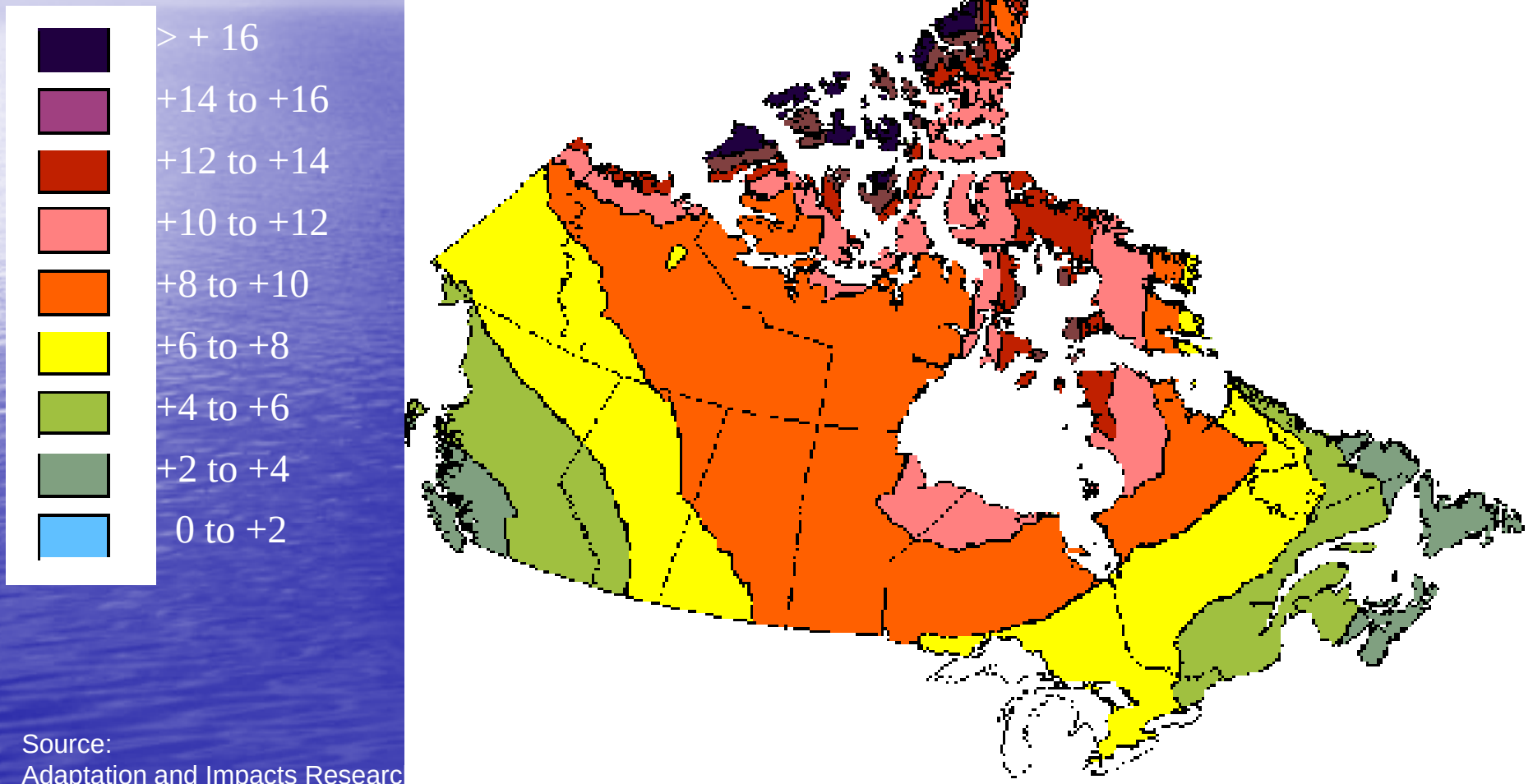
Source: Michael Pidwirny, Dept. of Geography, Okanagan University College

Canadian Context; Impacts

- Temperature
- Precipitation
- Habitat
- Arctic Ice
- Water Temperature
- Coasts under Threat
- Extreme Weather Events

Projected Temperature Increase - Winter 2090

(December, January, February)

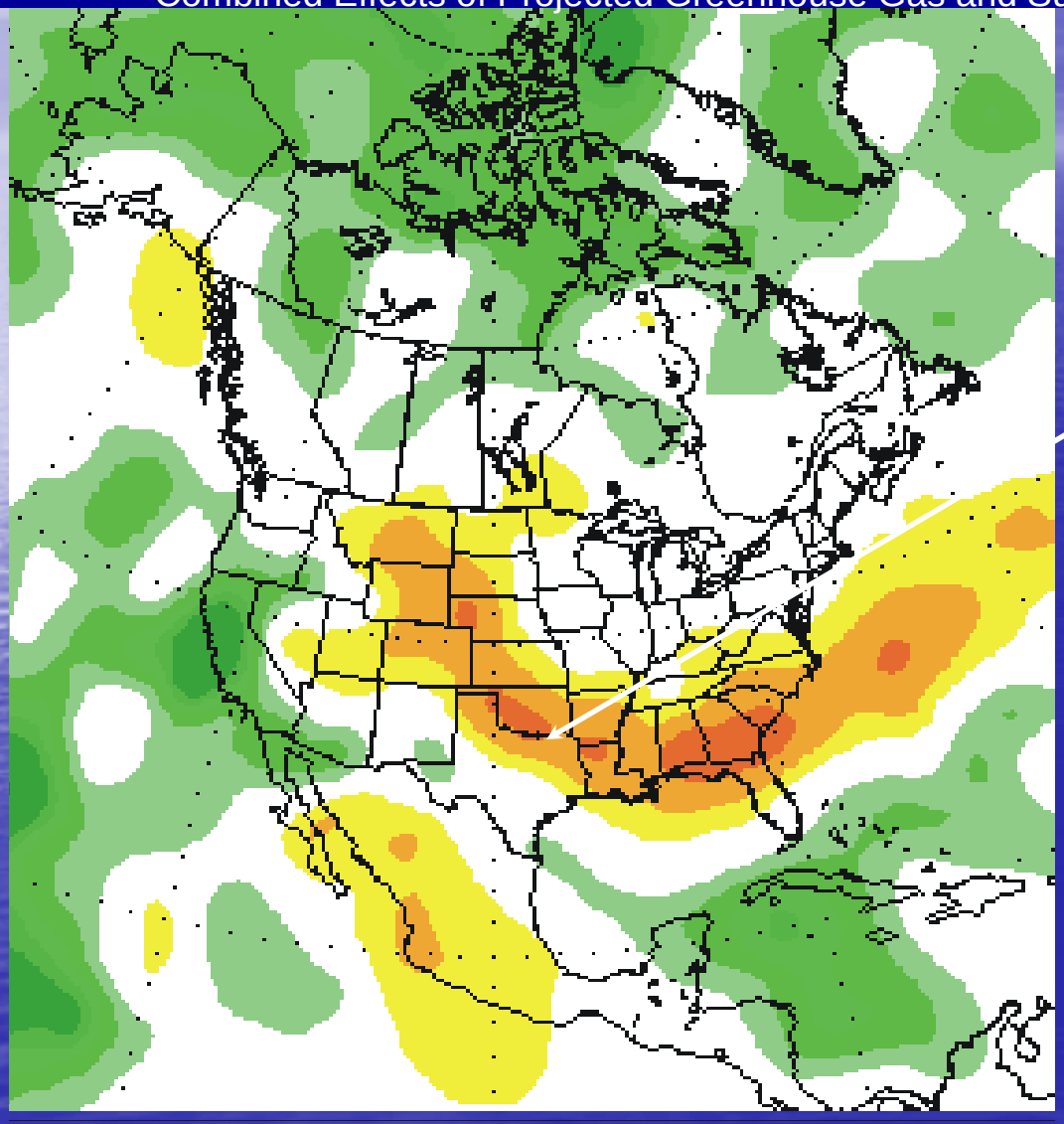


Source:
Adaptation and Impacts Researc
Envionment Canada, 1999

Projected Summer Precipitation Change

1975-1995 & 2080-2100

Combined Effects of Projected Greenhouse Gas and Sulphate Aerosol Increases

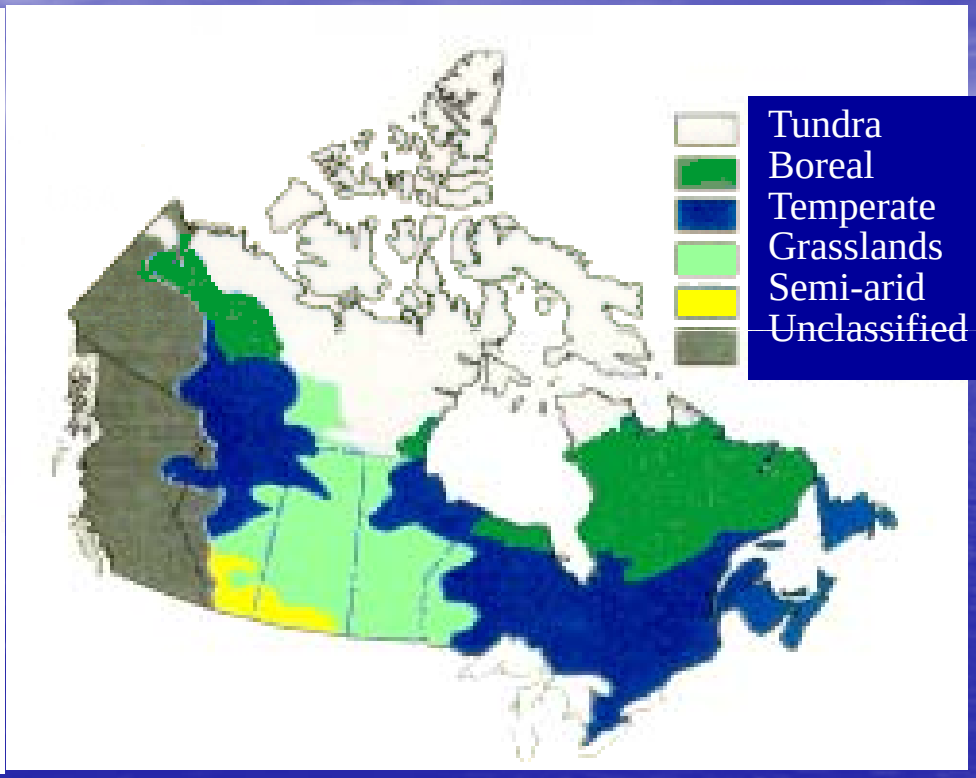


Precip. % Change

-75 - -30
-30 - -20
-20 - -10
-10 - 0
0 - 10
10 - 20
20 - 30
30 - 40
40 - 50
50 - 75
75 - 100
100 +

Source: Atmospheric Environment Service, Envionment Canada

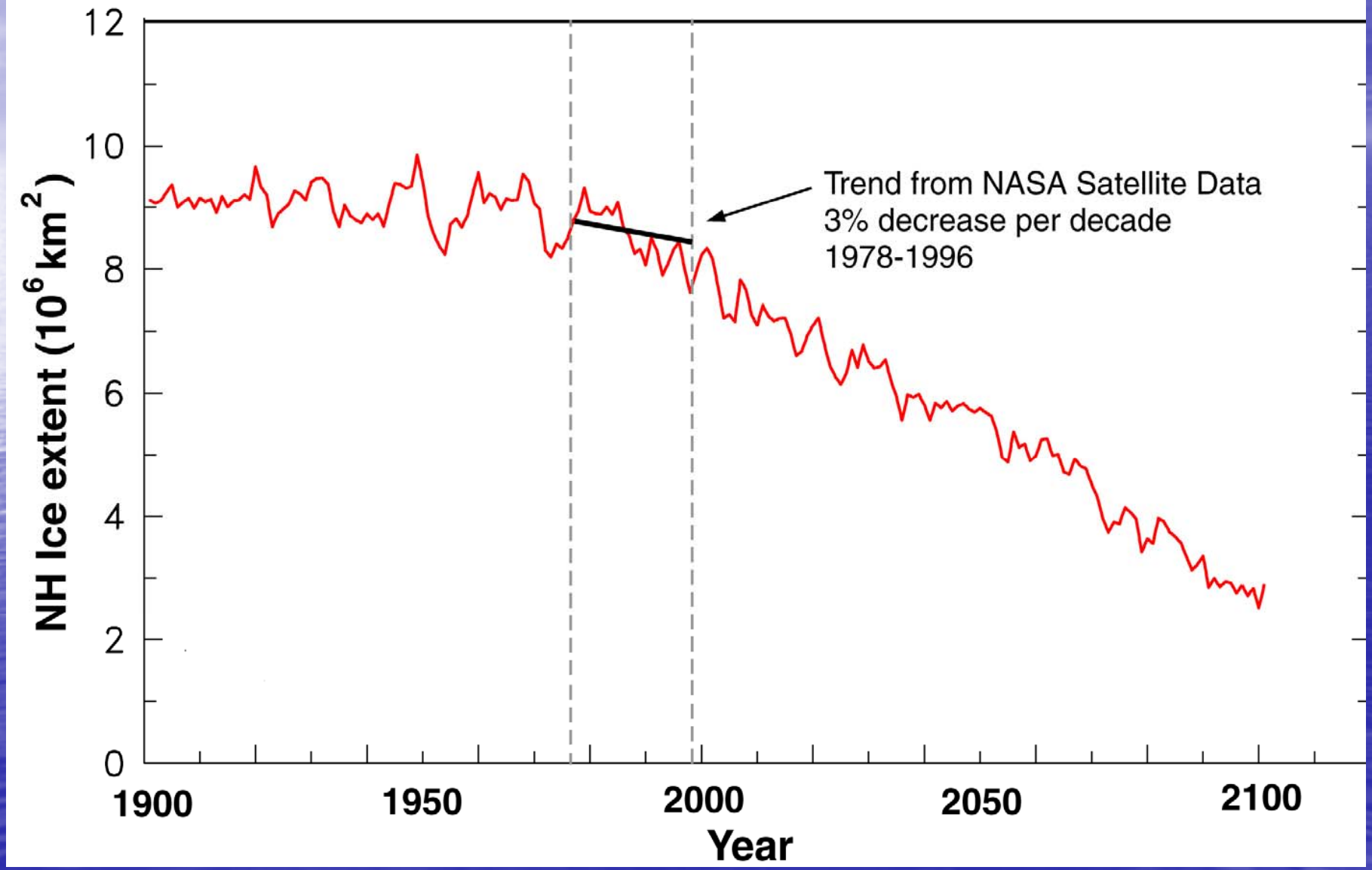
Changes in Forest and Grassland Climate Zone Boundaries



- The doubled CO_2 map shows vegetation that would be expected if climate were the only determinant of vegetation type.
- However, soil conditions and life cycles limit the rate of forest migration.
- Existing forests will be stressed before they can migrate.

Maps simplified from: Rizzo and Wiken, Climatic Change 21 (1), 37-56, 1992

Projected Changes in Arctic Sea Ice Cover



Source: G. Flato; Hengeveld 2000

Impacts on Wildlife

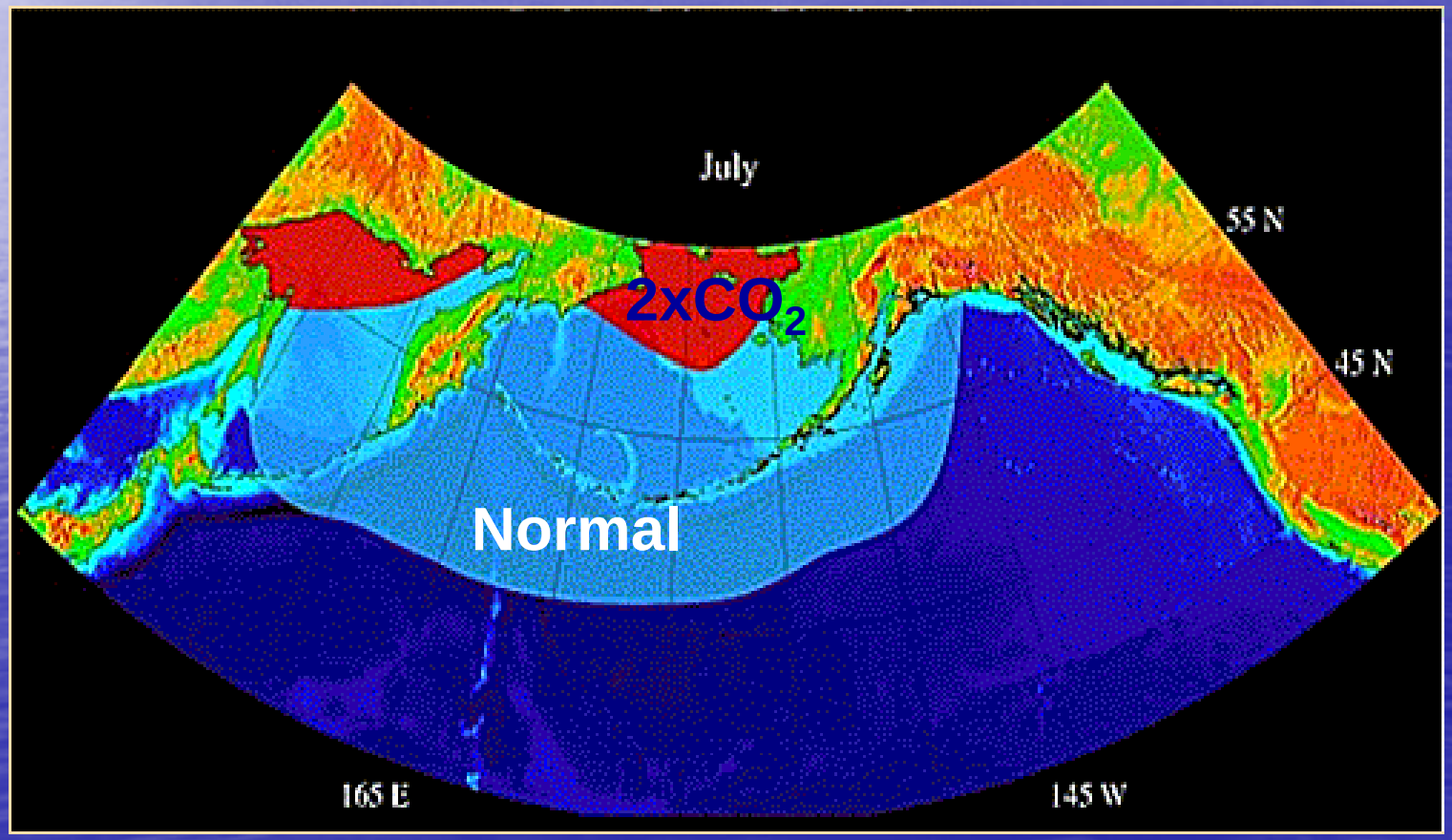
Climate Change Linked to Population Declines

Examples:

- Caribou
- Polar Bears
- Sea birds
- Grey Jays
- Whales
- Coral
- Marsupials

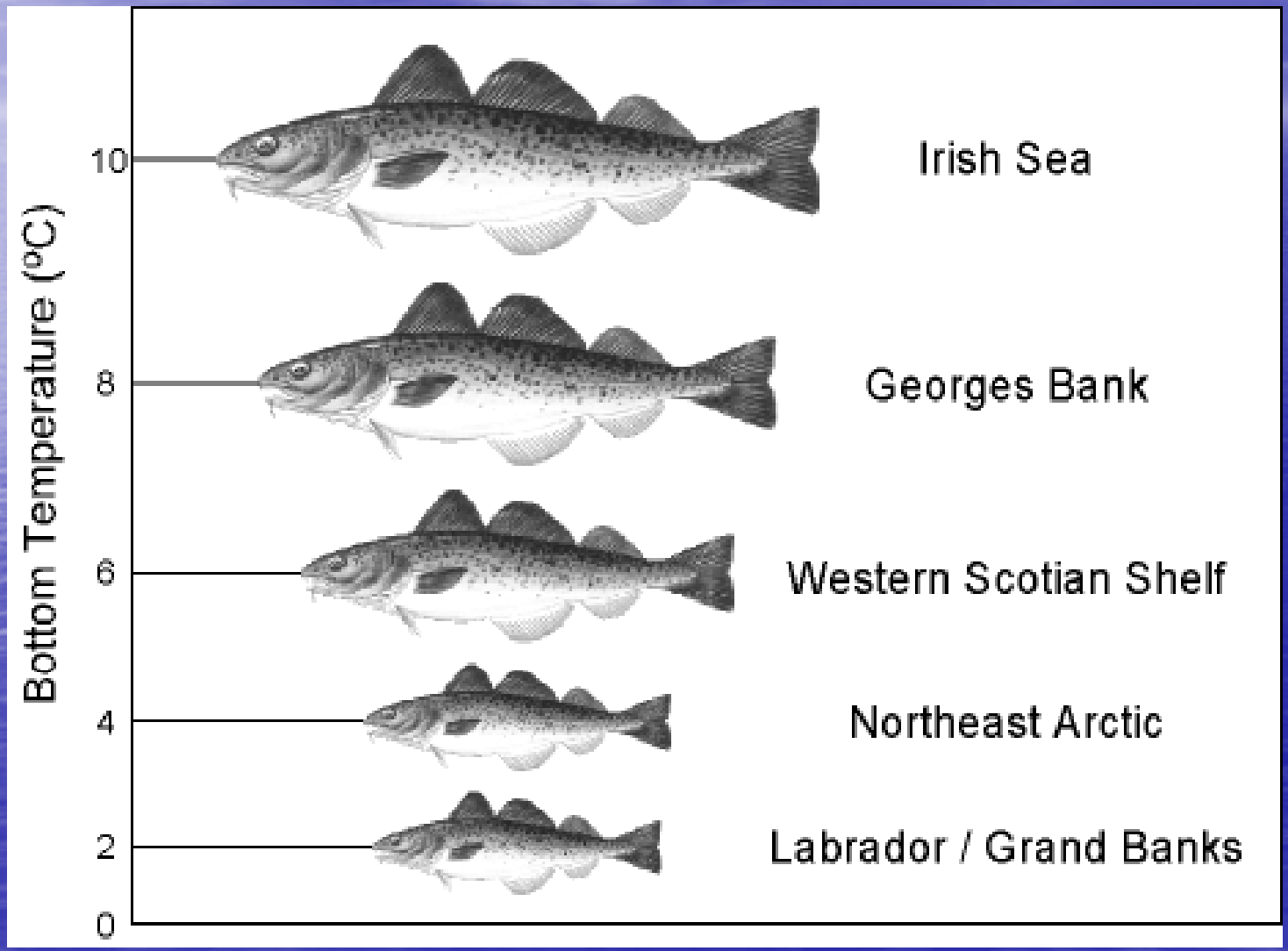
Climate Change Will Affect Our Fisheries Resources

Sockeye Salmon Distribution



Fish Growth Rate - Temperature Sensitivity

Relative sizes of 4-year old cod, at different bottom temperatures.

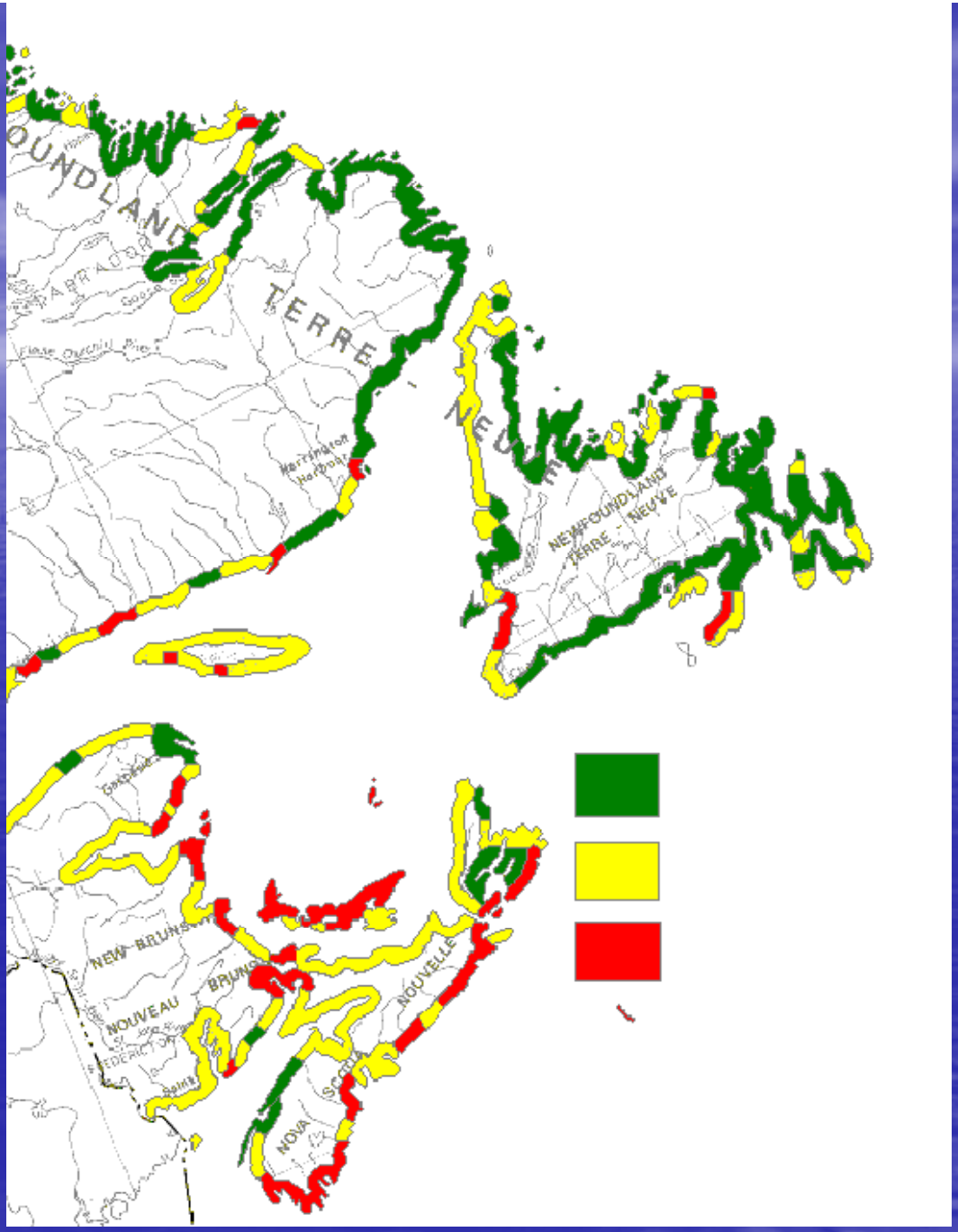


Source: Ken Drinkwater, DFO, Bedford Institute of Oceanography, Dartmouth, Nova Scotia

Risk From Sea Level Rise Influenced by:
- coastal elevation
- rock type
- wave heights
- land rising / falling

Land is subsiding in Maritimes and southern Newfoundland by about 30 cm per century.

Atlantic Region has the greatest length of sensitive coast in Canada.



Source: Geological Survey of Canada Bulletin 505, *Sensitivity of the Coasts of Canada To Sea Level Rise*, 1998.

Expected Impact of Storm Surge & Sea Level Rise

Near- total flooding from Amherst to Sackville

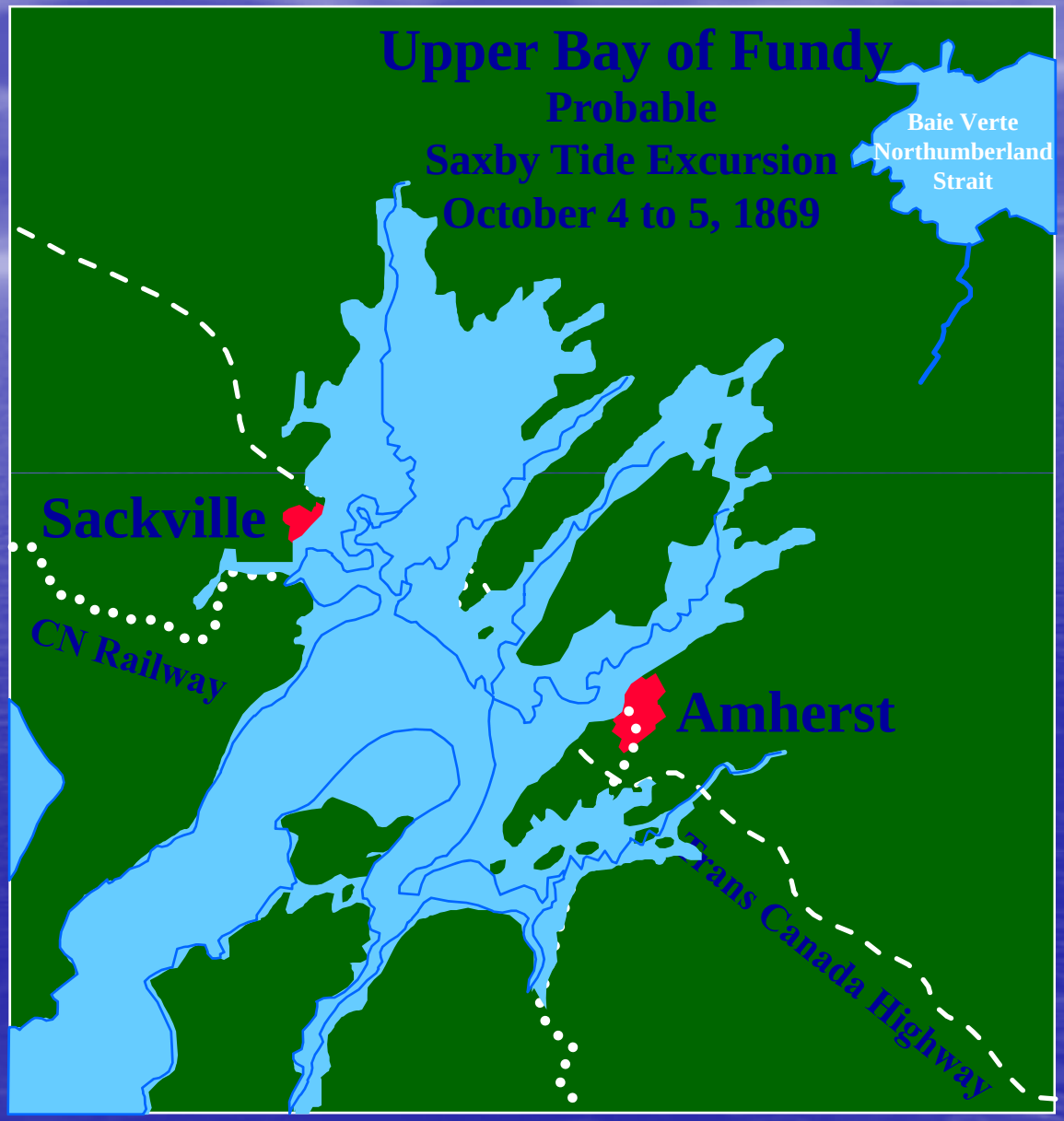
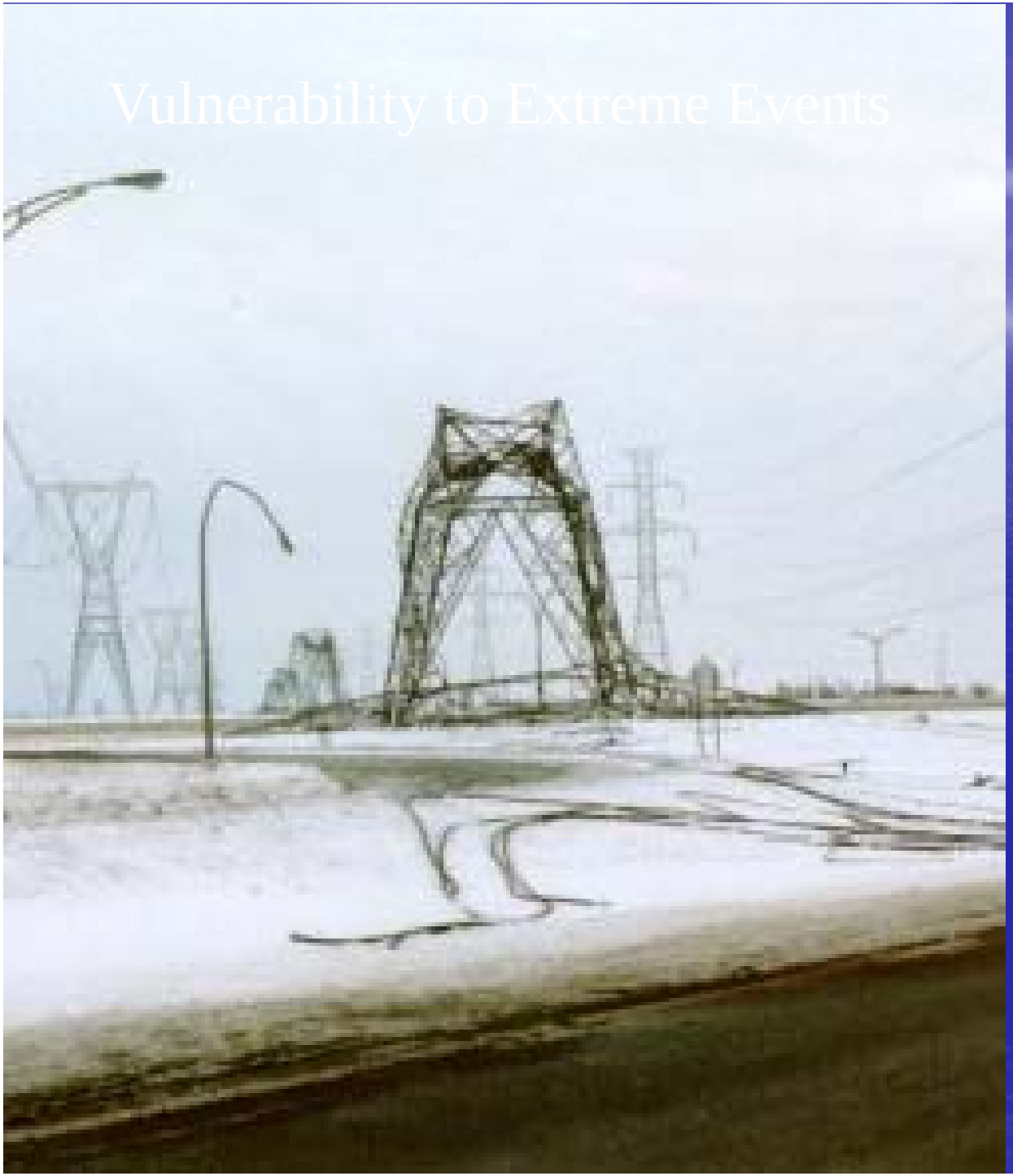


Image credit: John Shaw, Geological Survey of Canada

Environment Canada Environnement Canada

Vulnerability to Extreme Events



Quebec Ice Storm (January, 1998)

Over 1,000 transmission towers and 30,000 wooden utility poles were downed.

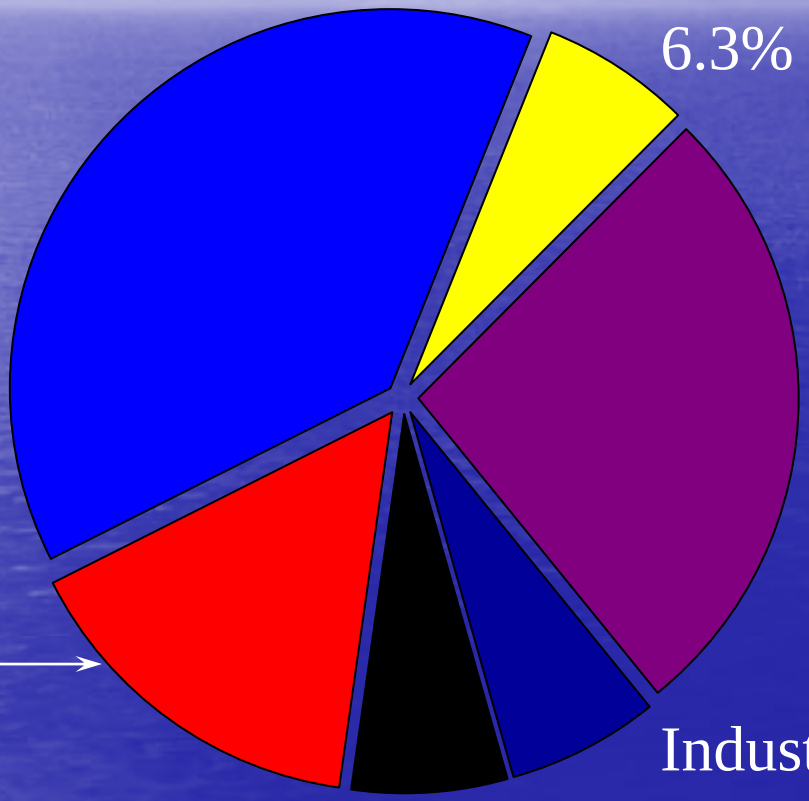
A month after the storm 700,000 people still without power.

Over $1 Billion in Insurance Claims

Canadian Context; GHG Sources

- Contributing Gases:
  - CO2 (~ 75%)
  - CH4 (~ 15%)
  - NOx (~ 8%)
  - A # of other gases with minor but growing contributions
- Sources by Human Activity
  - Energy versus Non-energy

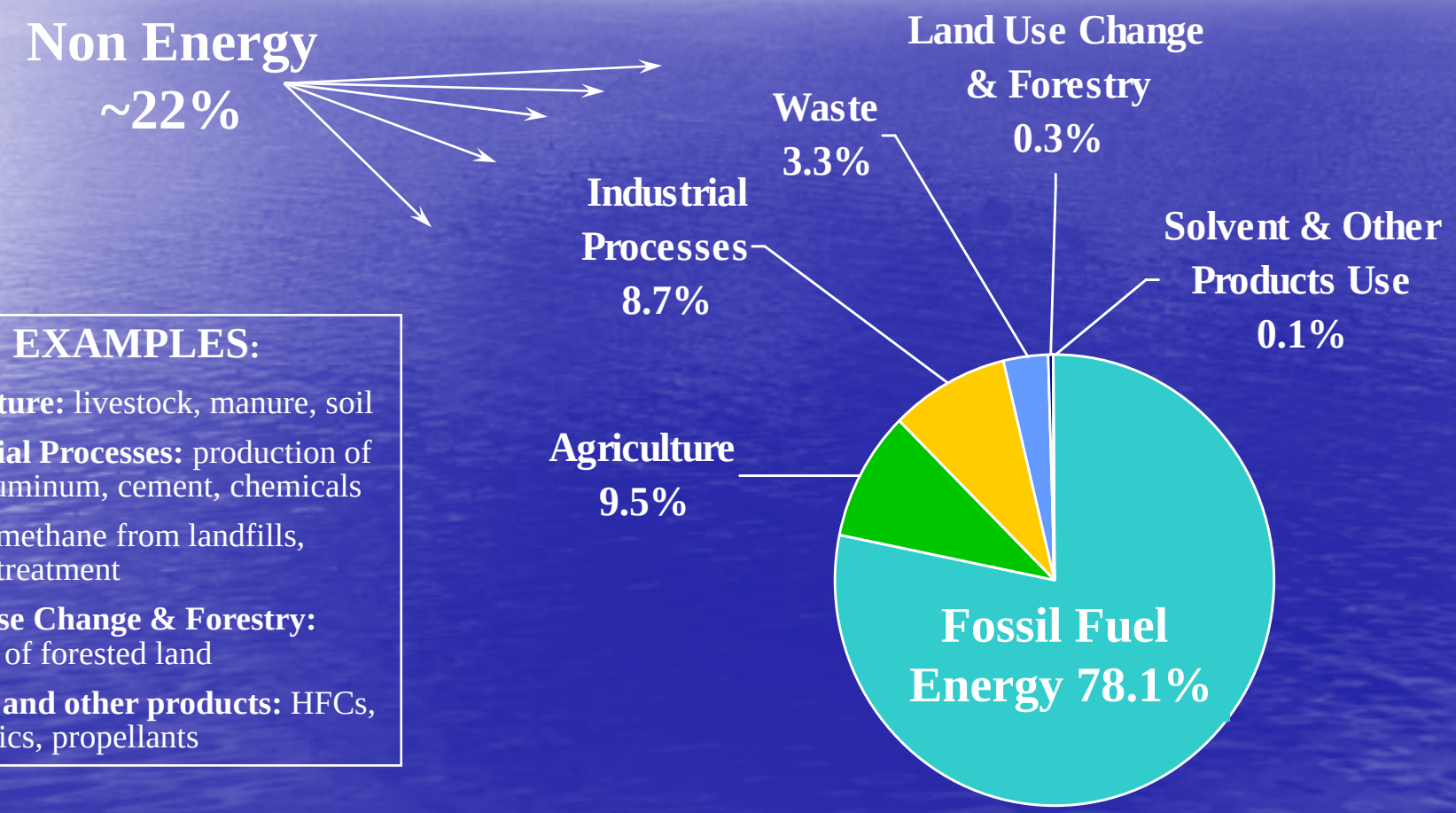
Greenhouse Gas Sources in Nova Scotia (1997)



Total: 20.0 Megatonnes CO_2 eq

Source: Canada's Greenhouse Gas Inventory, 1999

Non-Energy Sources of Greenhouse Gases in Canada (1996)



EXAMPLES:

Agriculture: livestock, manure, soil

Industrial Processes: production of steel, aluminum, cement, chemicals

Waste: methane from landfills, sewage treatment

Land Use Change & Forestry: clearing of forested land

Solvent and other products: HFCs, anesthetics, propellants

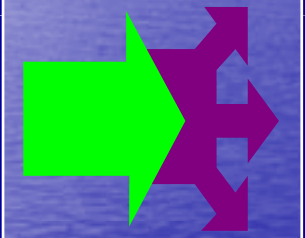
Total emissions: approximately 671 million tonnes of carbon dioxide equivalent (1996).
Source: *Canada's Greenhouse Gas Inventory*, Environment Canada, 1999, p. 5

Canadian Context; Reductions

- Use Less Energy
  - Efficiency & Conservation
- Fuel Switching
  - Fossil Fuels to Renewables
- Non-energy sources
  - Methane from agriculture etc
- Offsets
  - Sinks

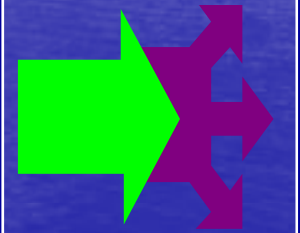
Fossil Fuel Production and Use

- COAL
- OIL
- GASOLINE
- NATURAL GAS
- PROPANE
- ETC



Emissions

- NO_X
- VOCs
- SO_2
- N_2O
- CH_4
- CO_2
- PARTICULATE MATTER
- TOXICS



Atmospheric Issues

- ACID RAIN
- SMOG
- CLIMATE CHANGE
- HAZARDOUS AIR POLLUTANTS
- STRATOSPHERIC OZONE DEPLETION

Why Else Use Less Fossil Fuels?

- **Supply Not Sustainable** - Once all fossil fuels are burned, then nothing left for future generations
- **Security of Supply** - 1973 Arab oil embargo
- **Damage to Habitat**
  - Coal: Tailings, Strip Mines, Acid Mine Drainage
  - Oil: tanker spills, tank leakage, pipeline corridors
  - Natural Gas: sour gas wells, pipeline corridors
- **Reduce Consumption of Other Resources**
- **Save Money**
- **Economic Benefits from New Industries**

Opportunities for Environmental Industries

Electricity

- Wind, solar
- New investments in high efficiency power plants / co-generation

Heating / Cooling

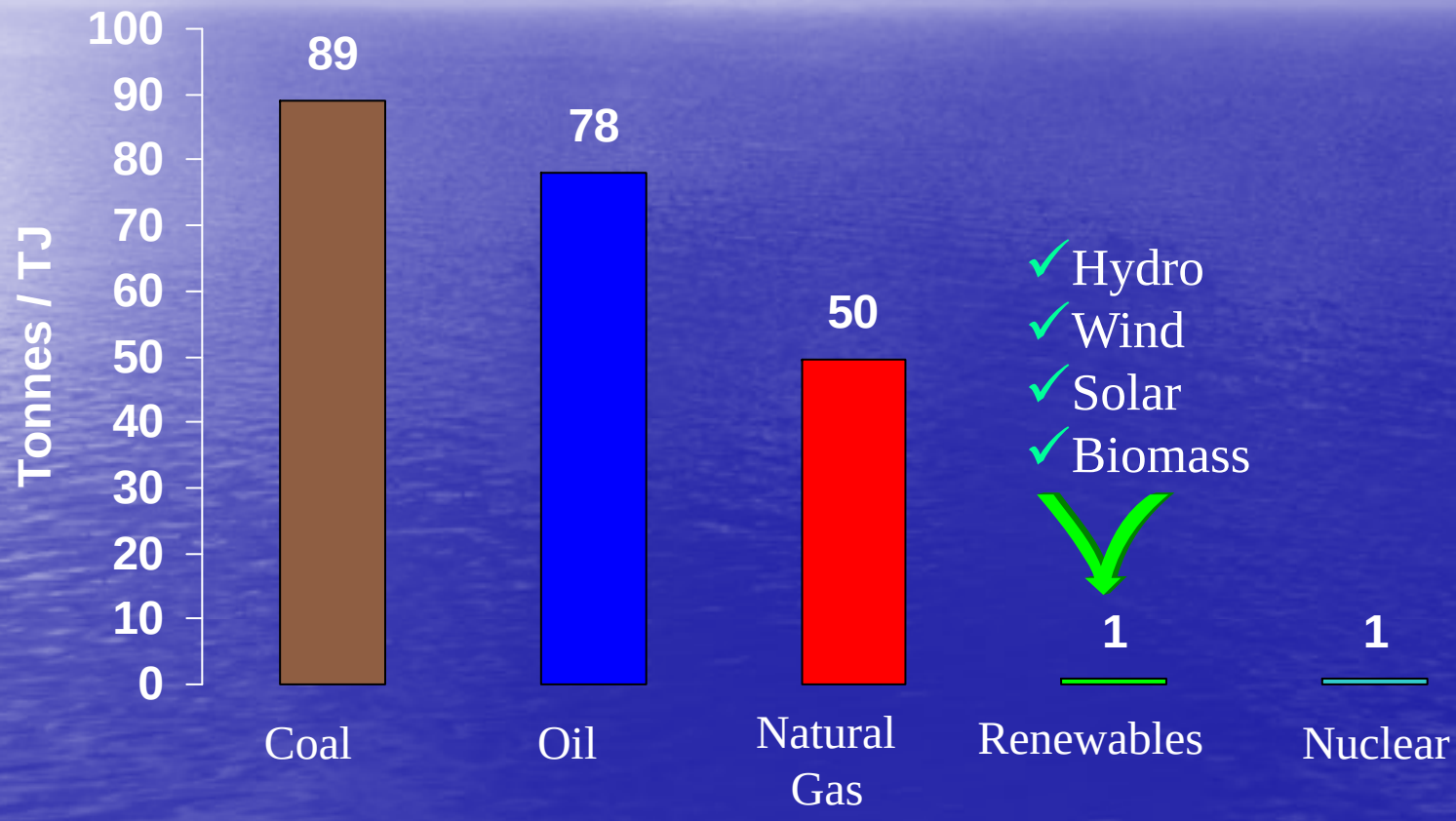
- Energy retrofits
- Community energy systems

Transportation

- Revitalized rail system
- Mass transit
- Fuel cells

•Industrial Energy Use

Direct CO_2 Emissions Per Unit of Energy



What is Needed to Replace the World's Crude Oil (71 million barrels/day)

- **Biomass** 3-7 million km^2 short rotation tree crops
- **Methanol** 8-19 million km^2 of trees
- **Ethanol** 5 million km^2 of arable land (sugar cane)
  (US cropland is about 1.56 million km^2)
- **Solar-Hydrogen** 448,000 km^2 of land for photovoltaics
  (Tucson, Ariz.)
- **Wind** turbines 1.3 million km^2 of land, 403 million
  (500 kW capacity ea., 3 per ha.)
- **Hydro-electricity** 3.1 million km^2 of land

Source: 1998: Lightfoot, H.Douglas and Chris Green: New Sources of Energy are Needed To Halt Global Warming in Policy Options (May) p. 17

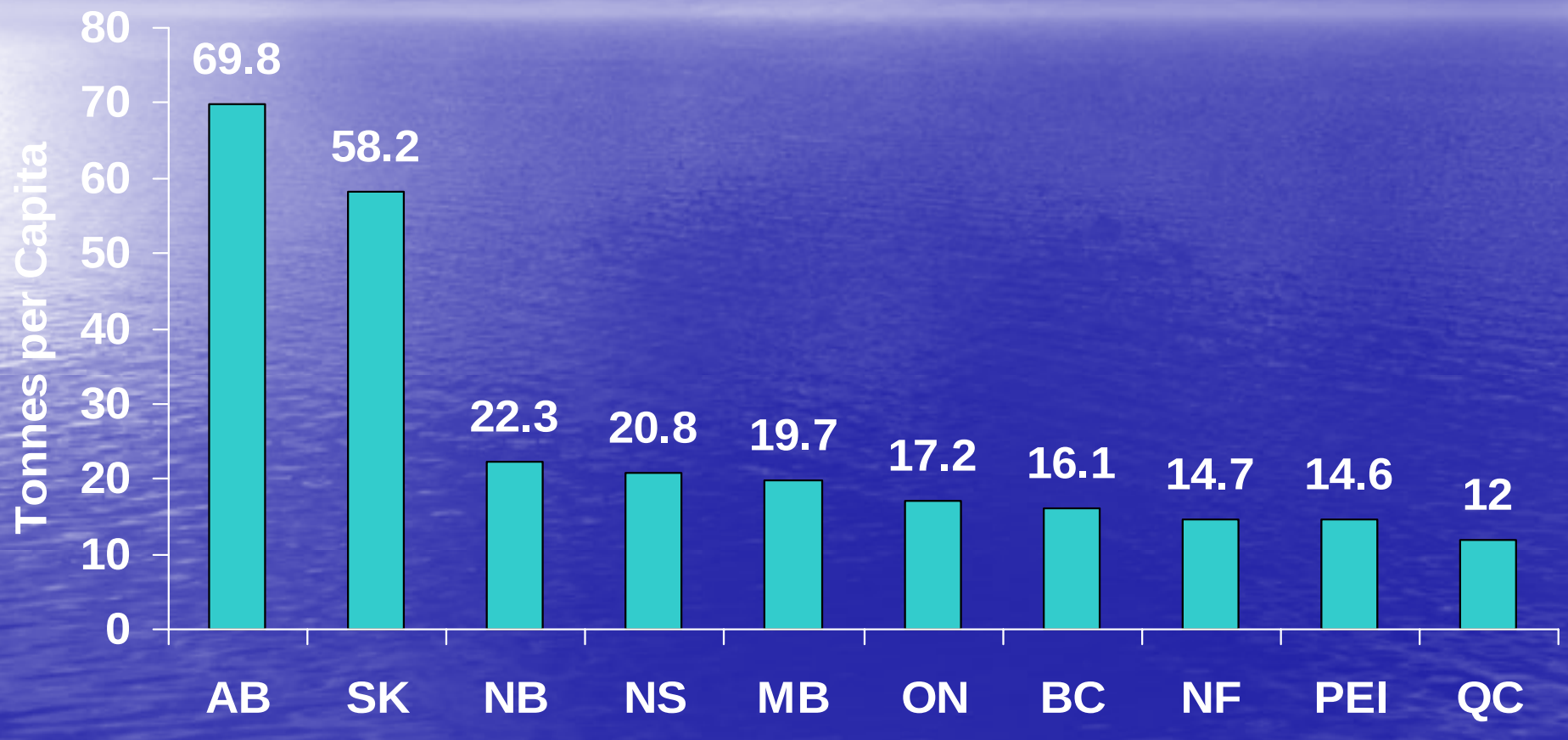
GHG Reduction Strategies

- *1. Use Less Energy (~ 60 - 70%)*
- *2. Renewables (~ 20 - 40%)*
- *3. Cleaner Fossil Fuels (Transition)*
- *4. Efficient Fossil Fuels (Transition)*
- *5. Non-Energy GHG (Small)*
- *6. Sinks (Temporary)*

Canadian Context; Fed/Provincial

- Very Different Costs and Benefits
- National Energy Policy
- Pre-Kyoto Fed/Prov Negotiations
- Fed/Prov Since 1997

Canadian Greenhouse Gas Emissions (1996)
Tonnes of CO_2 Equivalent per Capita



Calculated from: Statistics Canada. 1996 population (available at www.statcan.ca)

•F. Neitzert, K. Olsen, and P. Collas. *Canada's Greenhouse Gas Inventory: 1997 Emissions and Removals with Trends*. 1999. Environment Canada (available at http://www.ec.gc.ca/pdb/ghg)

Canadian Context; Fed/Provincial

- Very Different Costs and Benefits
  - Net Energy Producer or Consumer
  - Source of Electricity
  - Change since 1990
  - Plans for Future Economic Development
- National Energy Policy
- Pre-Kyoto Fed/Prov Negotiations
- Fed/Prov Since 1997

Canada & International Issues

- General
- Sinks
- Mechanisms
- Compliance
- Long Term Issues, Beyond 2012

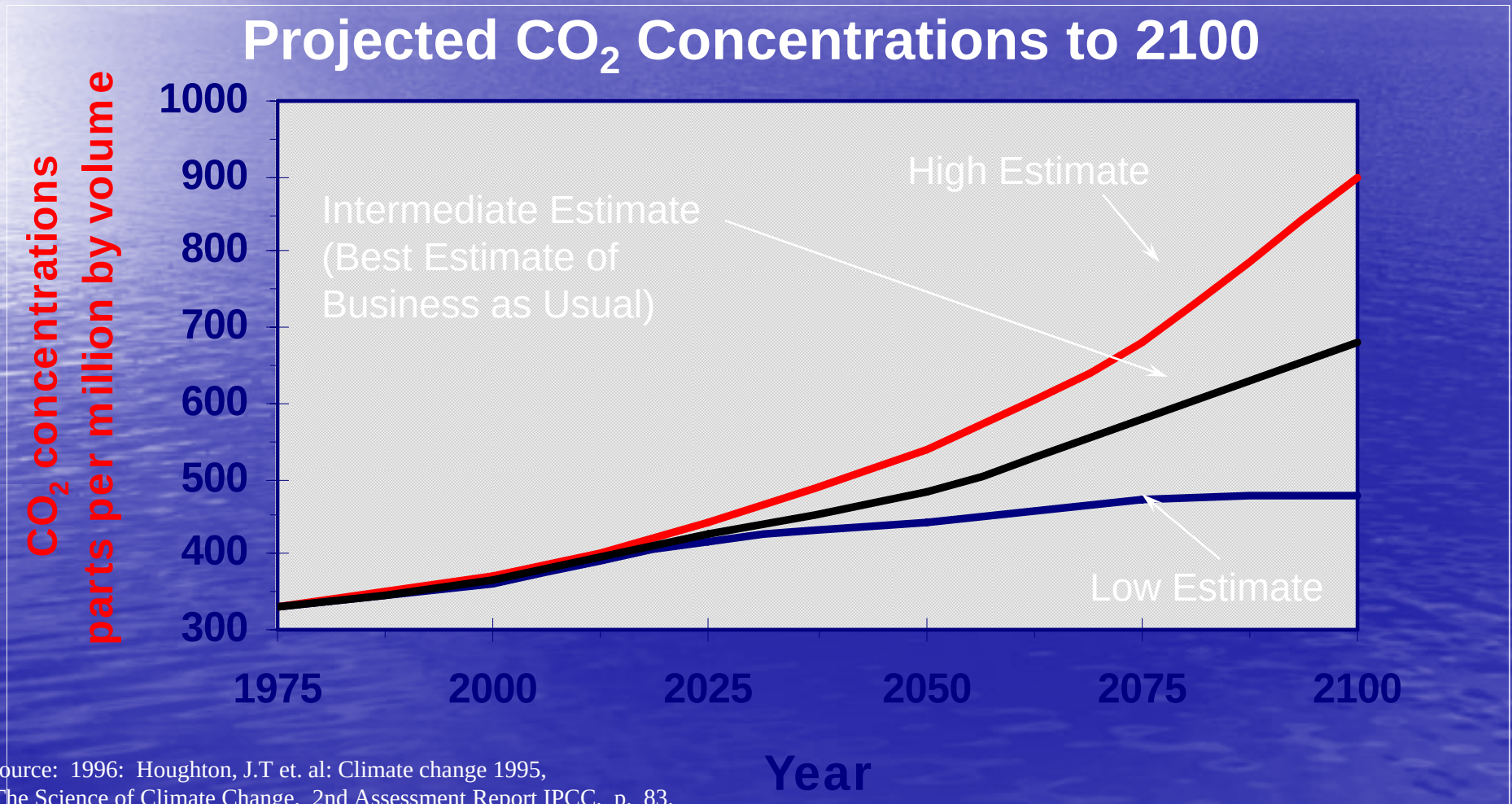
Kyoto Protocol
Emission Reduction Obligations

Party	Per cent reduction from 1990 levels
European Union	- 8
Switzerland	- 8
United States	- 7
Canada	- 6
Japan	- 6
Russian and FSU countries	0
Australia	+ 8

Overall reduction for all Parties combined is 5.2%

Atmospheric CO_2 Levels Depend on What We Do

- **Kyoto is an important first step in reducing risk**
- **Further reductions will be needed**



Source: 1996: Houghton, J.T et. al: Climate change 1995,
The Science of Climate Change, 2nd Assessment Report IPCC. p. 83.

Human Impacts on the Carbon Cycle

(Gt = Gigatonnes of Carbon)

Atmosphere

750 Gt in 1990 (Preindustrial = 580 Gt)

Carbon Accumulation = 3.3 Gt/year

Combustion
6.3 Gt/year

Ocean Uptake
2.3 Gt/year

Deforestation
1.6 Gt/year

Land Uptake
2.3 Gt/year

Fossil Fuels

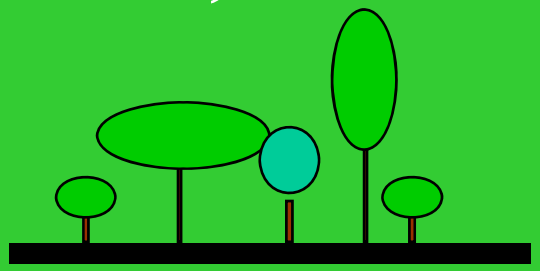
5,000-10,000 Gt

Oceans

40,000 Gt

Land Biomass

2,000 Gt



Sources: 1. IPCC. *Land Use, Land-Use Change, and Forestry, Summary for Policymakers.* 2000.
2. J. Houghton, *Global Warming: The Complete Briefing*. 1997.

Carbon Sinks

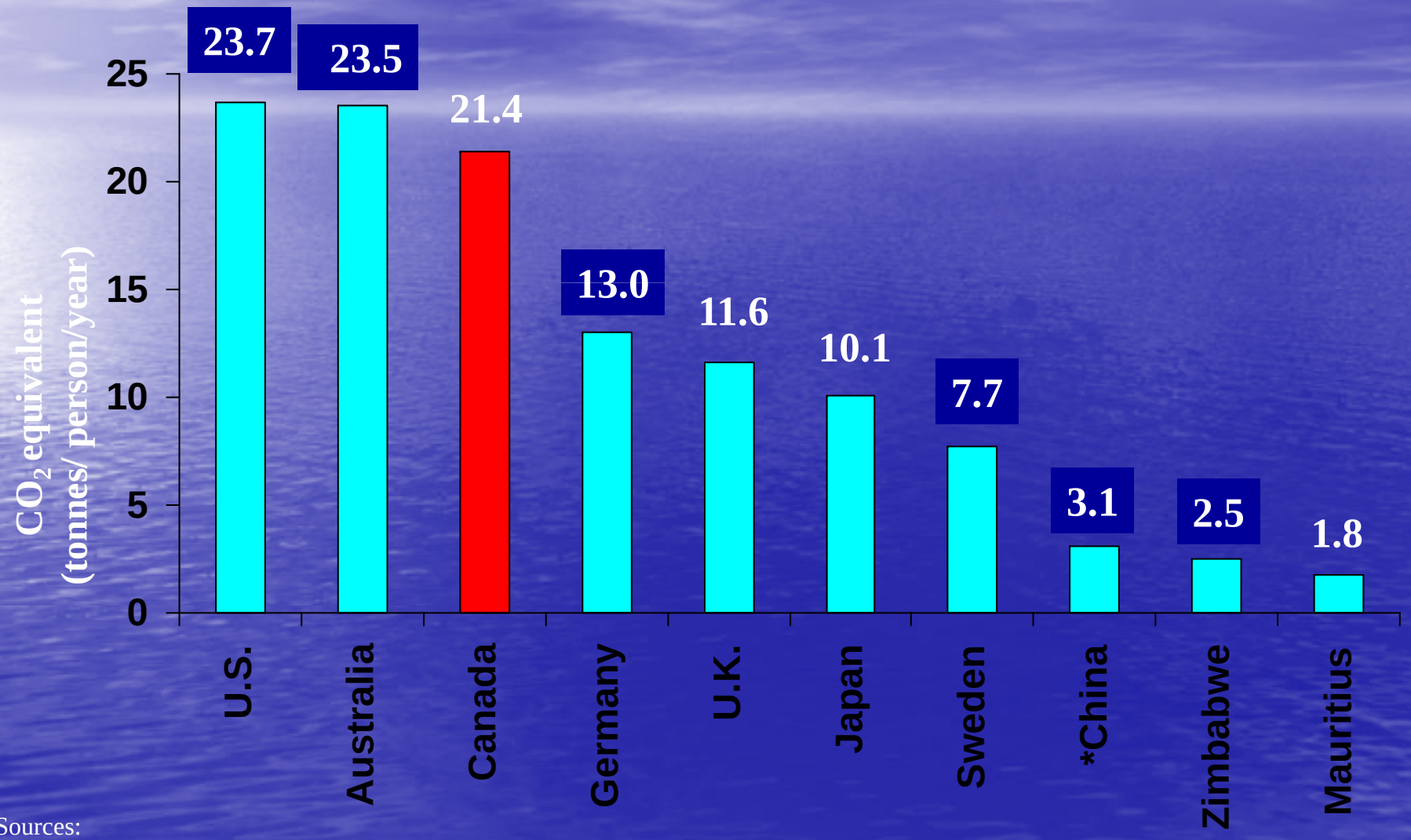
Land:
- Forestry
- Agriculture

Ocean:
- Surface
- Deep Ocean

Underground:
- Geological

These methods do not:
- conserve fossil fuels
- address air quality issues

Greenhouse Gas Emissions in Selected Countries
Tonnes of CO_2 Equivalent Per Person - 1994

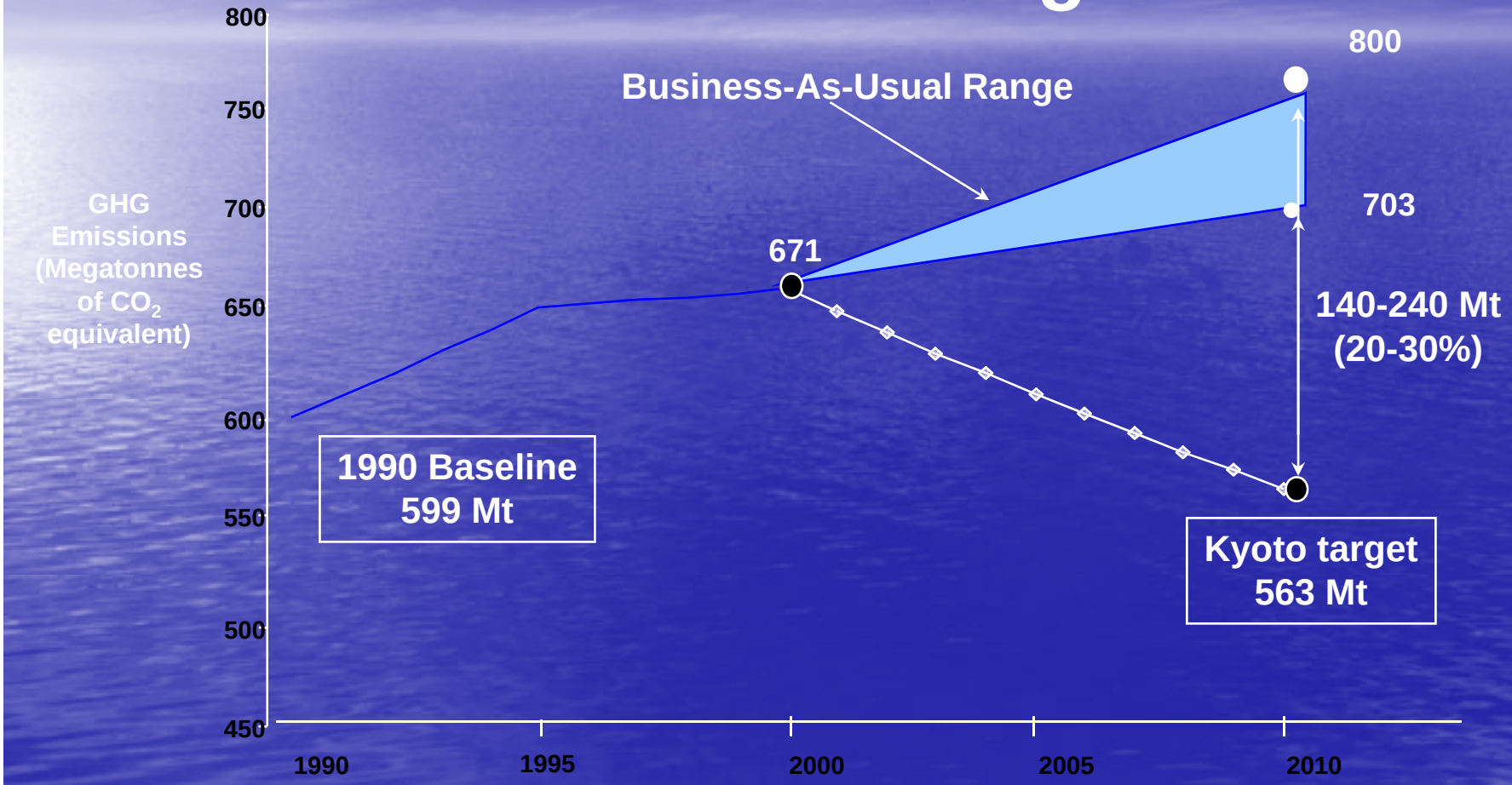


Sources:
Emissions Data - UNFCCC Greenhouse Gas Inventory Database, Populations - U.S. Bureau of the Census
* China - 1990 data, World Resources Institute

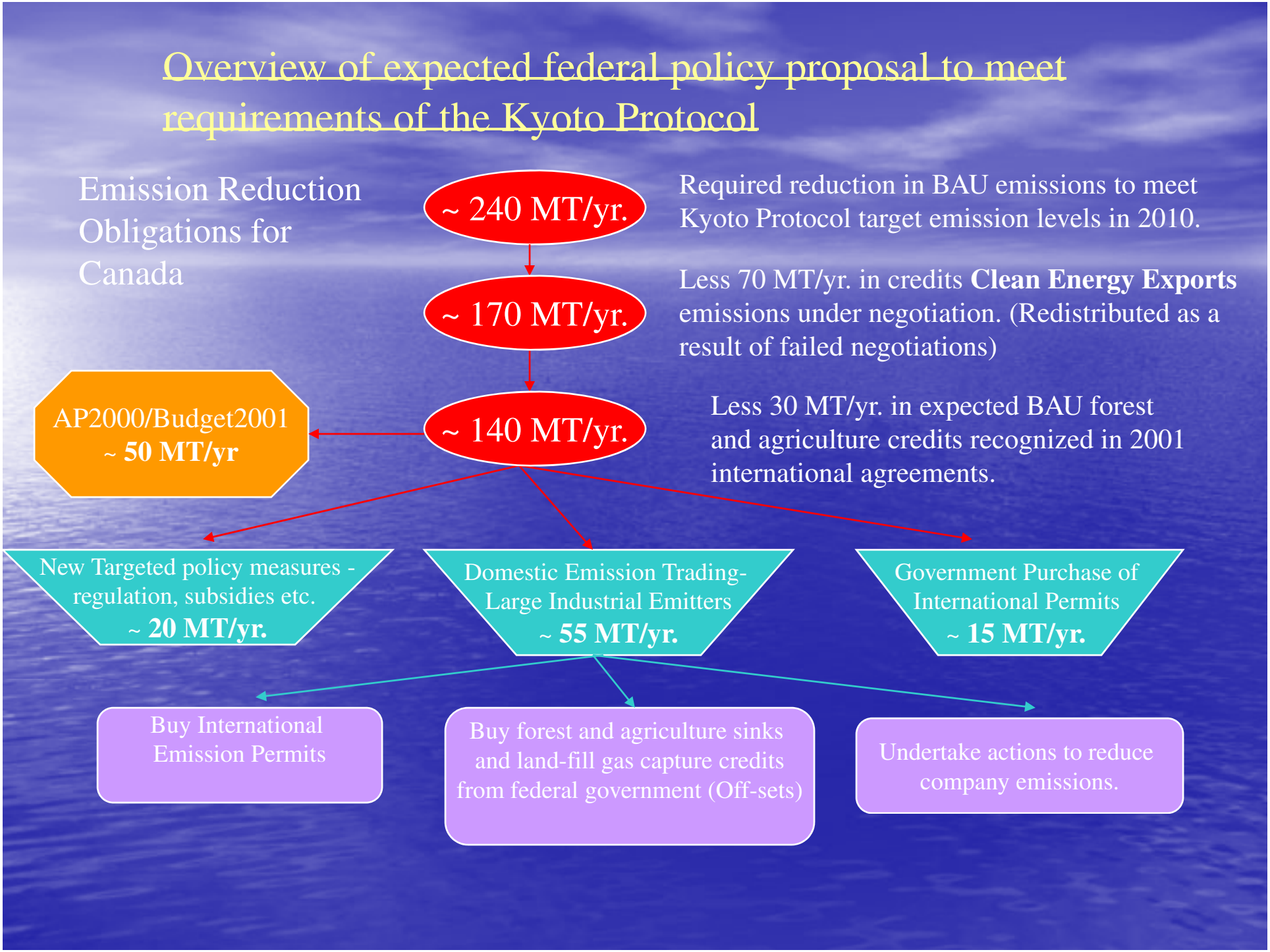
Implementing Kyoto In Canada

- The Federal Implementation Plan
  - The Context!
    - Kyoto or long term? (-6 or – 80%)
    - Domestic or Kyoto Mechanisms?
    - Users or Taxpayers?
    - Sinks, permanence and competing land use
  - Electricity Sector
  - Energy Exports
  - Large Industrial Emitters
  - Transportation
  - Buildings
  - The Citizen

Canada's Emission Reduction Obligation



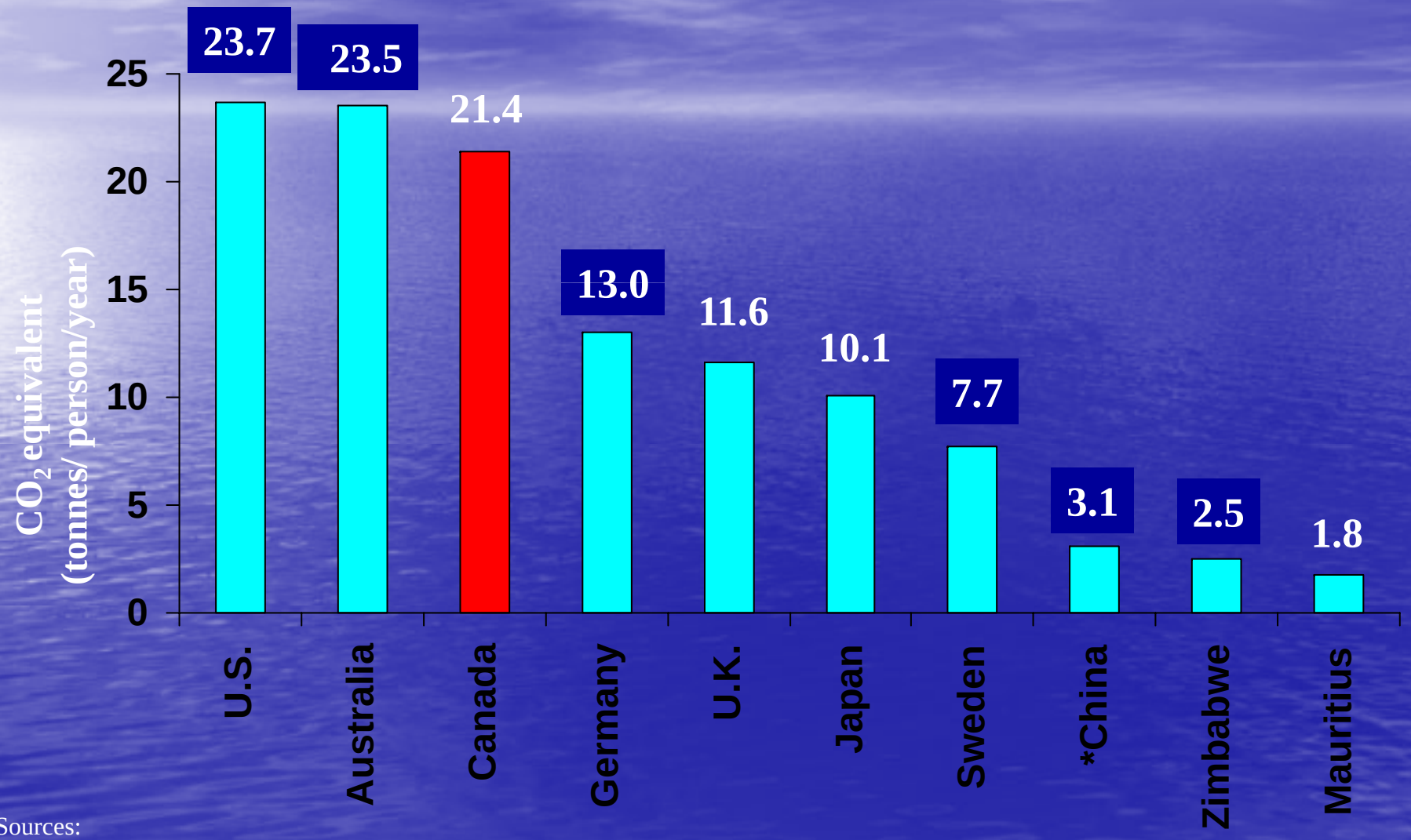
Overview of expected federal policy proposal to meet requirements of the Kyoto Protocol



Conclusion

- Future Prospects
- Canada's Role Internationally
- Canada's Challenges Domestically

Greenhouse Gas Emissions in Selected Countries
Tonnes of CO_2 Equivalent Per Person - 1994



Sources:
Emissions Data - UNFCCC Greenhouse Gas Inventory Database, Populations - U.S. Bureau of the Census
* China - 1990 data, World Resources Institute

World Population Growth

0 AD to 2050 AD