A Temporal Inventory of Ammonia Emission from Agricultural Sources in Canada

International Emission Inventory Conference

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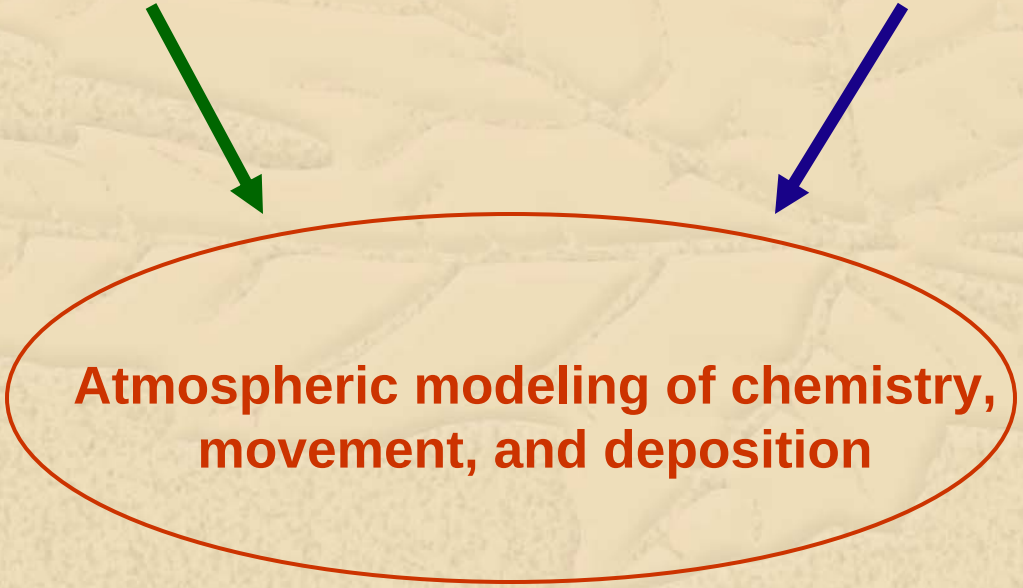
Policy drivers for NH_3 emission inventory in Canada

1. Environmental health

2. Human health
Air quality: $PM_{2.5}$



Environmental Impact

1. Deposition
(critical loading)

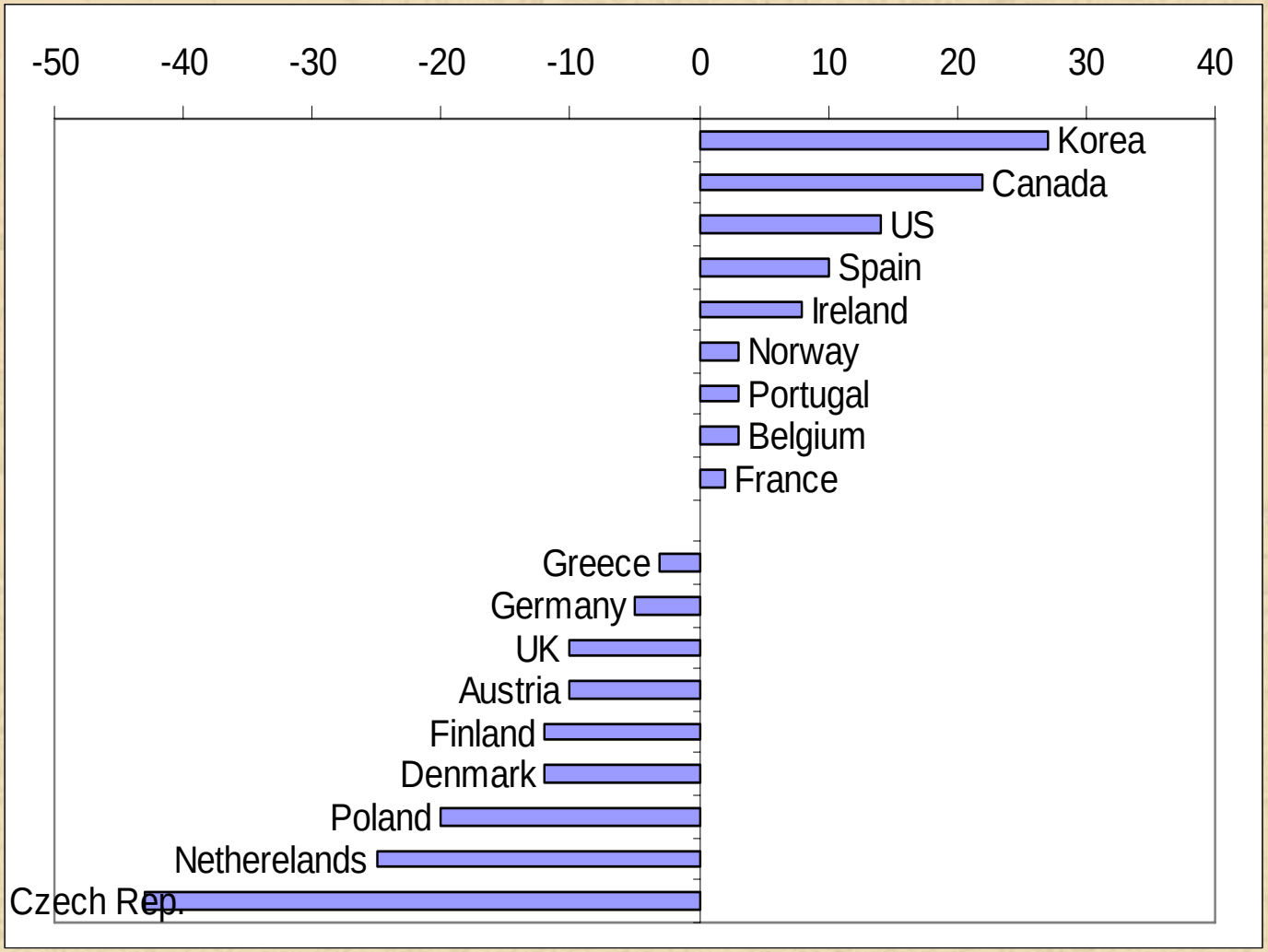
- Effects in estuarine water
- Forest ecosystems
- Biodiversity

2. Direct toxicity- most critical
proposed UNECE change in *critical level* from 8 to 2 ug m^{-3}
new information on vulnerability of lichens and bryophytes

Gothenburg Protocol: Reduce emission to 1990 levels

Effects of Gothenburg on NH_3 Emission

% Change 1992 to 2000



Health Impact

Ammonia is a precursor of secondary particulates $PM_{2.5}$

Ammonium (only basic gas)

+

Acid gases

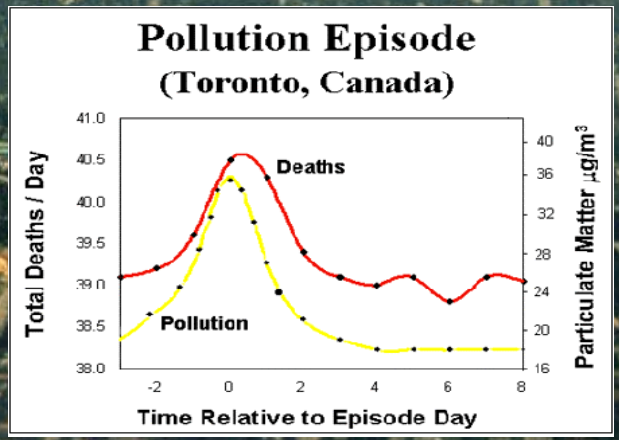
(sulphate, nitrate, chloride, organic)

=

Salts forming secondary particulates ($PM_{2.5}$)

Ambient particulate matter accelerates coagulation via an IL-6–dependent pathway

J. Clin. Invest., Oct 2007; 117: 2952 - 2961. Gökhan M. Mutlu, David Green, Amy Bellmeyer, Christina M. Baker, Zach Burgess, Nalini Rajamannan, John W. Christman, Nancy Foiles, David W. Kamp, Andrew J. Ghio, Navdeep S. Chandel, David A. Dean, Jacob I. Sznajder, and G.R. Scott Budinger



The View Ahead – Managing Visibility in BC

Tuesday, June 19th, 2007 • 8:30 to 4:30pm • Segal Graduate School of Business

Did You Know?

A single poor visibility day could result in a loss of almost $9 million in future tourist revenues for the Lower Mainland and Fraser Valley. (1)

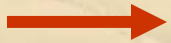
Why is Visibility Important to You?

1) July 2000 Environment Canada report, *The Impact of Visual air Quality on Tourism Revenues in Greater Vancouver and the Lower Fraser Valley*

Design Shift for Emission Inventories

Environmental

National inventory of annual emission



Health

Temporal and spatial resolution

NH_3 Inventories input to atmospheric models to refine policy

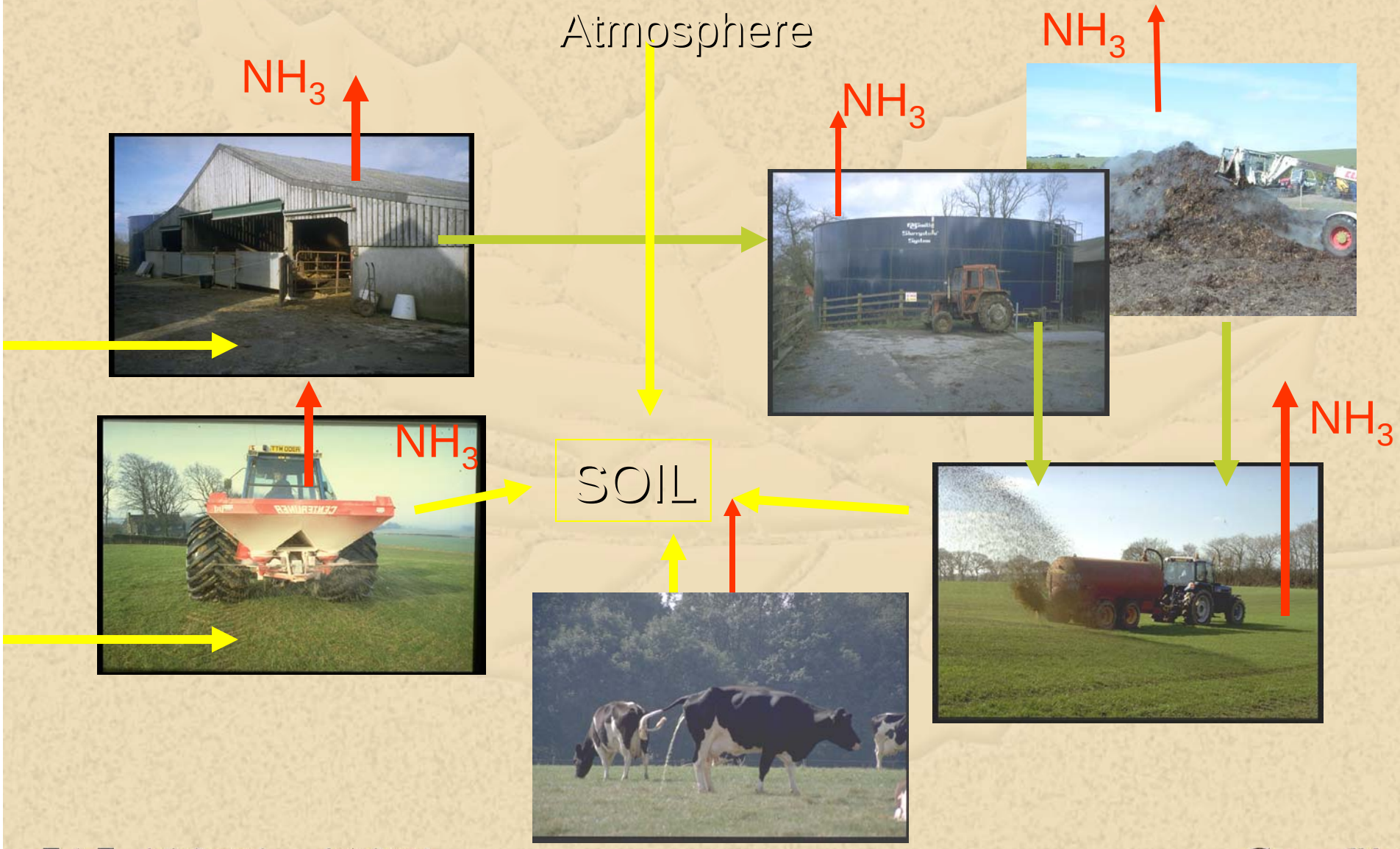
Reason:

Inventory + Atmospheric model (AURAMS)

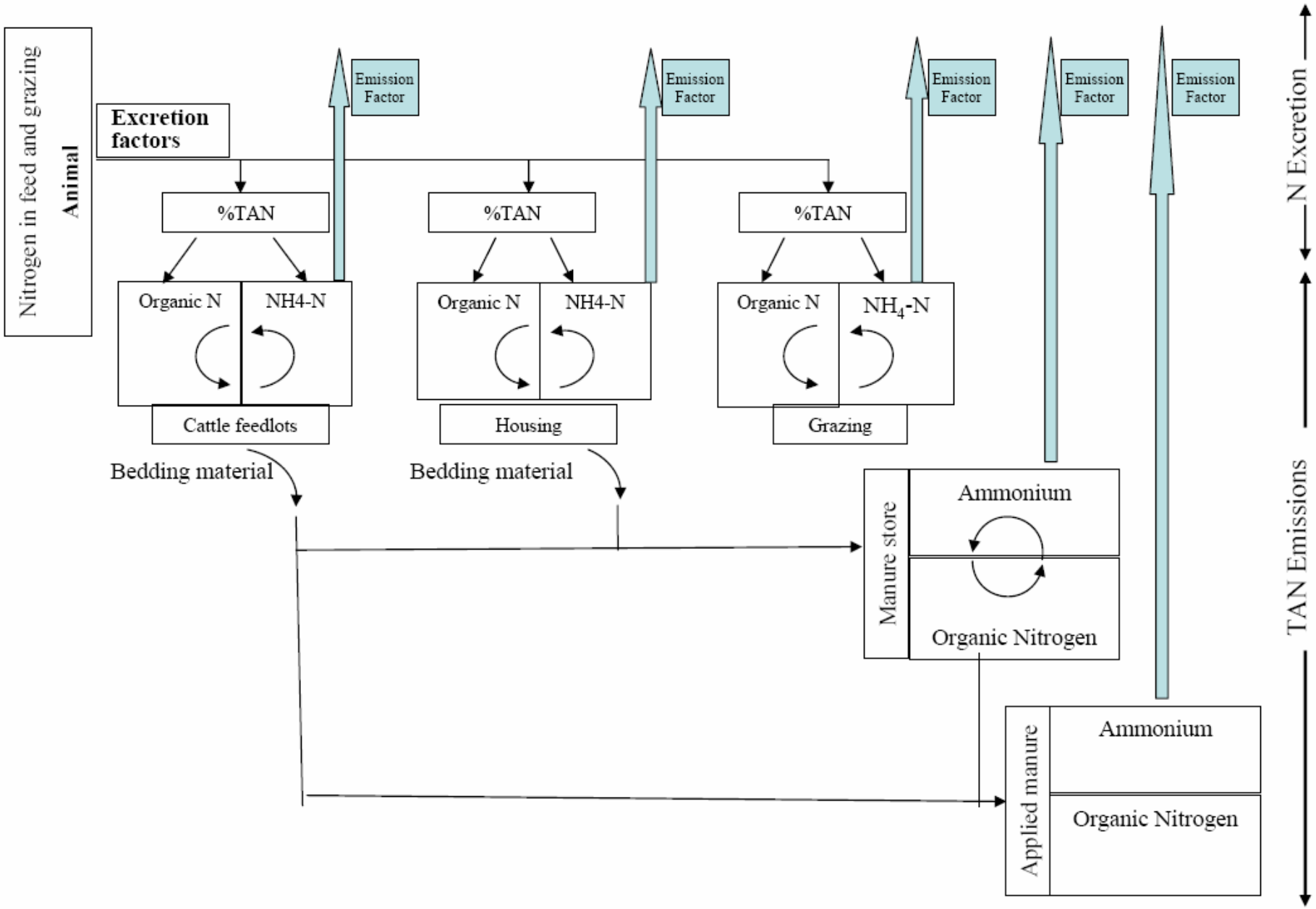
↓

Predict ambient levels of NH_4 and $PM_{2.5}$

Sources of ammonia- Dairy Sector

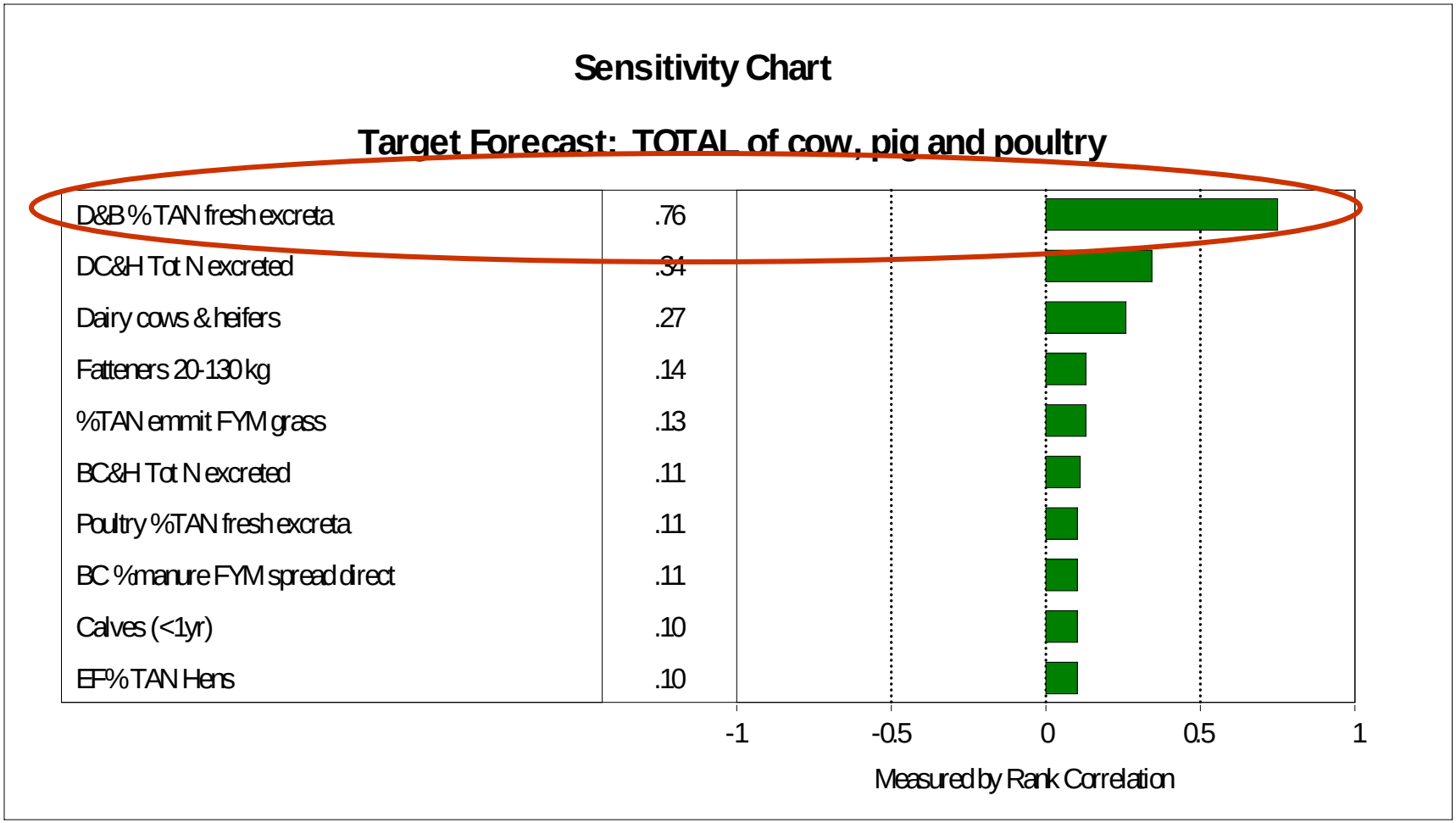


Mass Balance Livestock Ammonia Emission Inventory

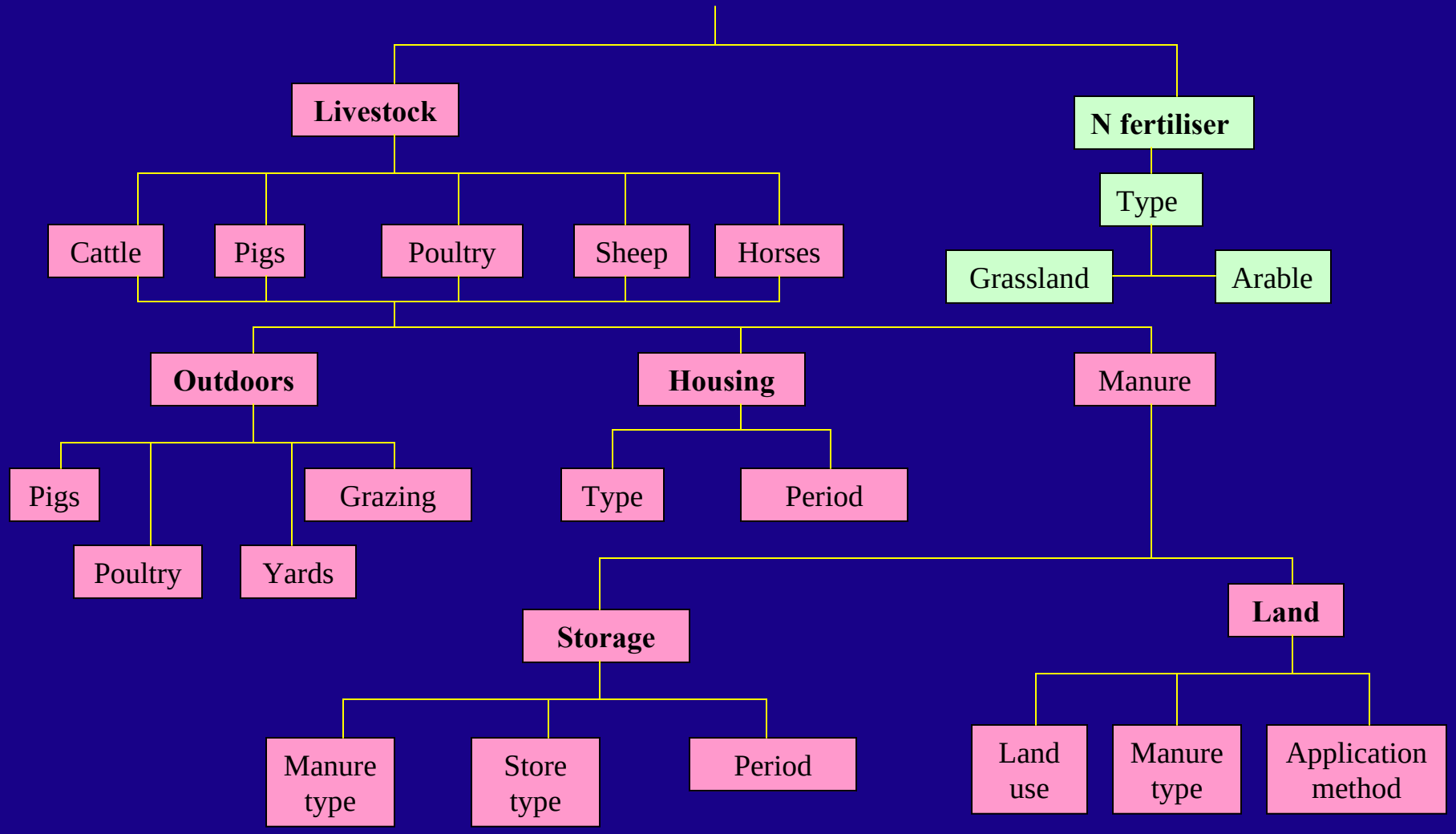


Sensitivity analysis of UK and Canadian NH3 emission models

Indicates the importance of livestock diets to emissions; in particular surplus protein consumption (From Sheppard et al. CJSS 2007, in press)



Accounting NH_3 Emission from Agricultural Sectors



D. Chadwick, IGER, UK

Calculating NH_3 emissions

<u>For each sector/ ecozone/ month</u>

Activity data x Emission factor

x

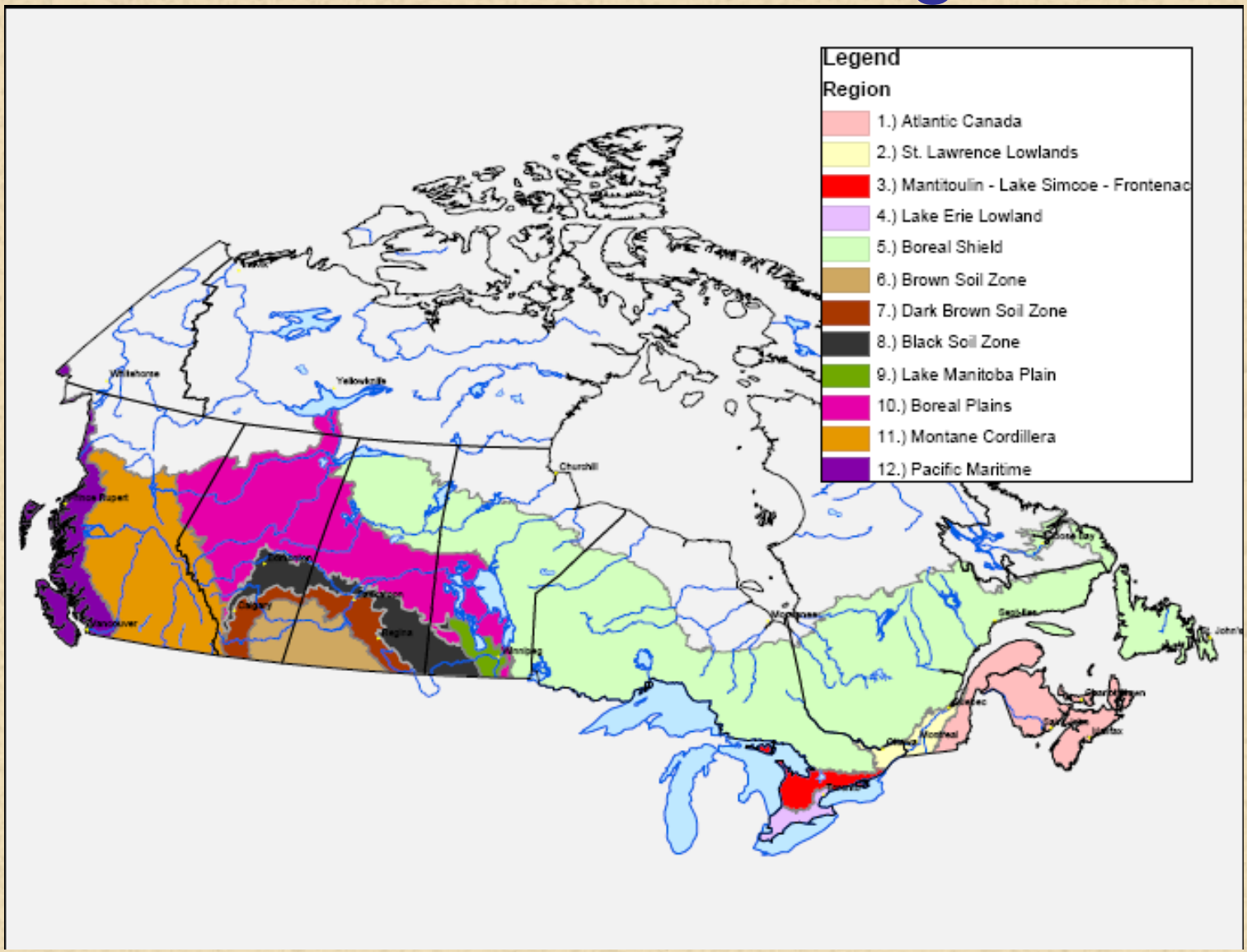
no. of animals or amt. fertilizer use

Sources of Activity Data

	LFPS [a] Survey	NAPS[b] Survey	Feed Industry[c]	Census	Expert[d]	Sales
Livestock Activities					**x**	
•FEED	x		x			
•Buildings	x					
•Grazing	x					
•Storage	x					
•Land application	x					
Crops Activities						
•N Fertilizer use		x			x	**x**

a Livestock Farm Practices Survey (StatCan, March 2006)
b Nitrogen Application Practices Survey (Ipsos Reid, Dec 2006)
c Feed Industry survey (Environment Canada, Spring 2006)
d Canadian Fertilizer Institute (PPI, Can Fert Inst and others, Fall 2006)

Stratification--Ecoregions

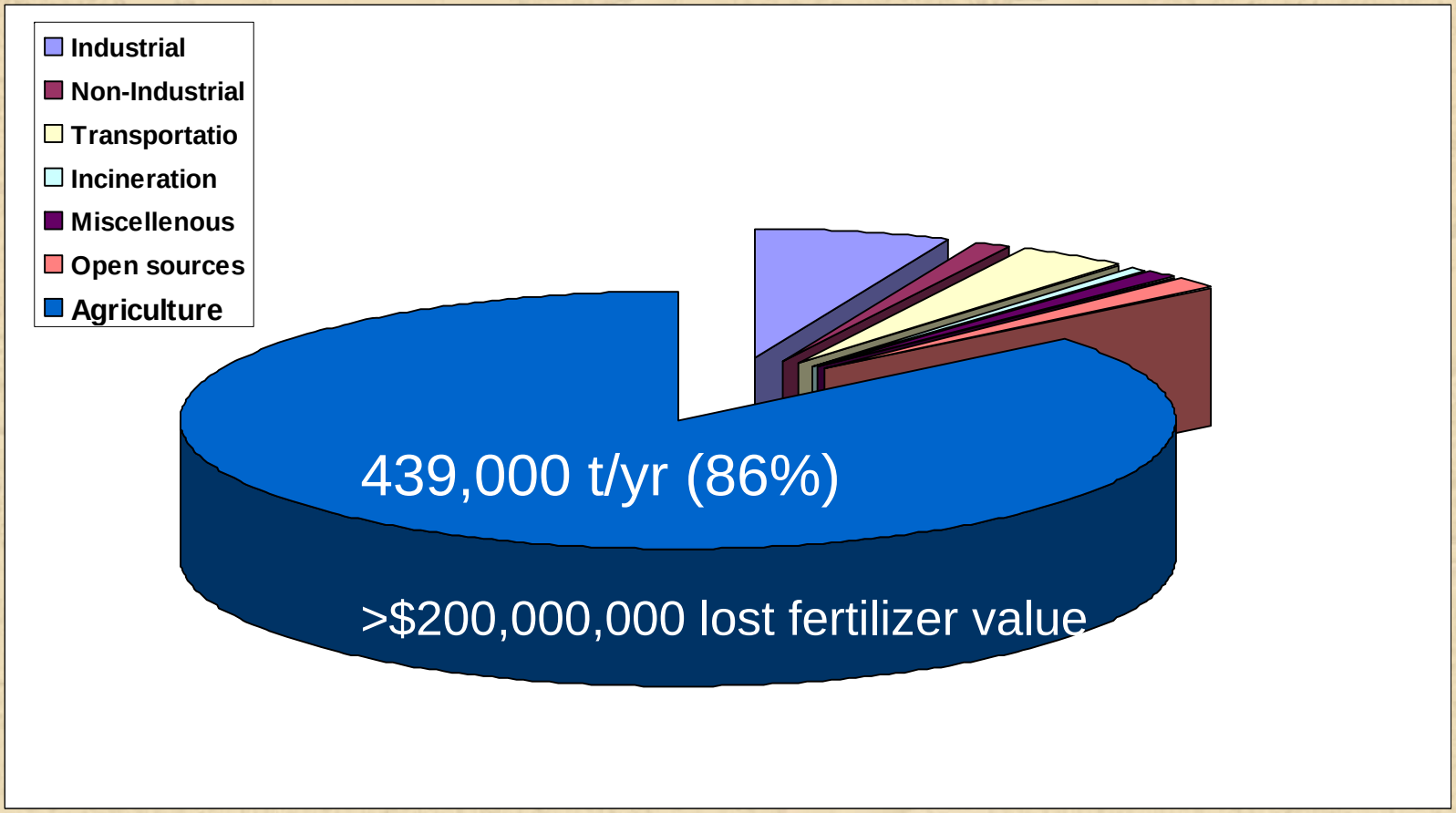


Livestock Farm Practices Survey 2006

	Responses	Rate of response
	farms	%
Atlantic, Ontario, Manitoba	**1,179**	**78.1**
Quebec	**433**	**66.2**
Sask, Albert and B.C.	**1,418**	**74.3**
Canada-wide	**3,030**	**74.4**
Large farms	**81**	**50.6**

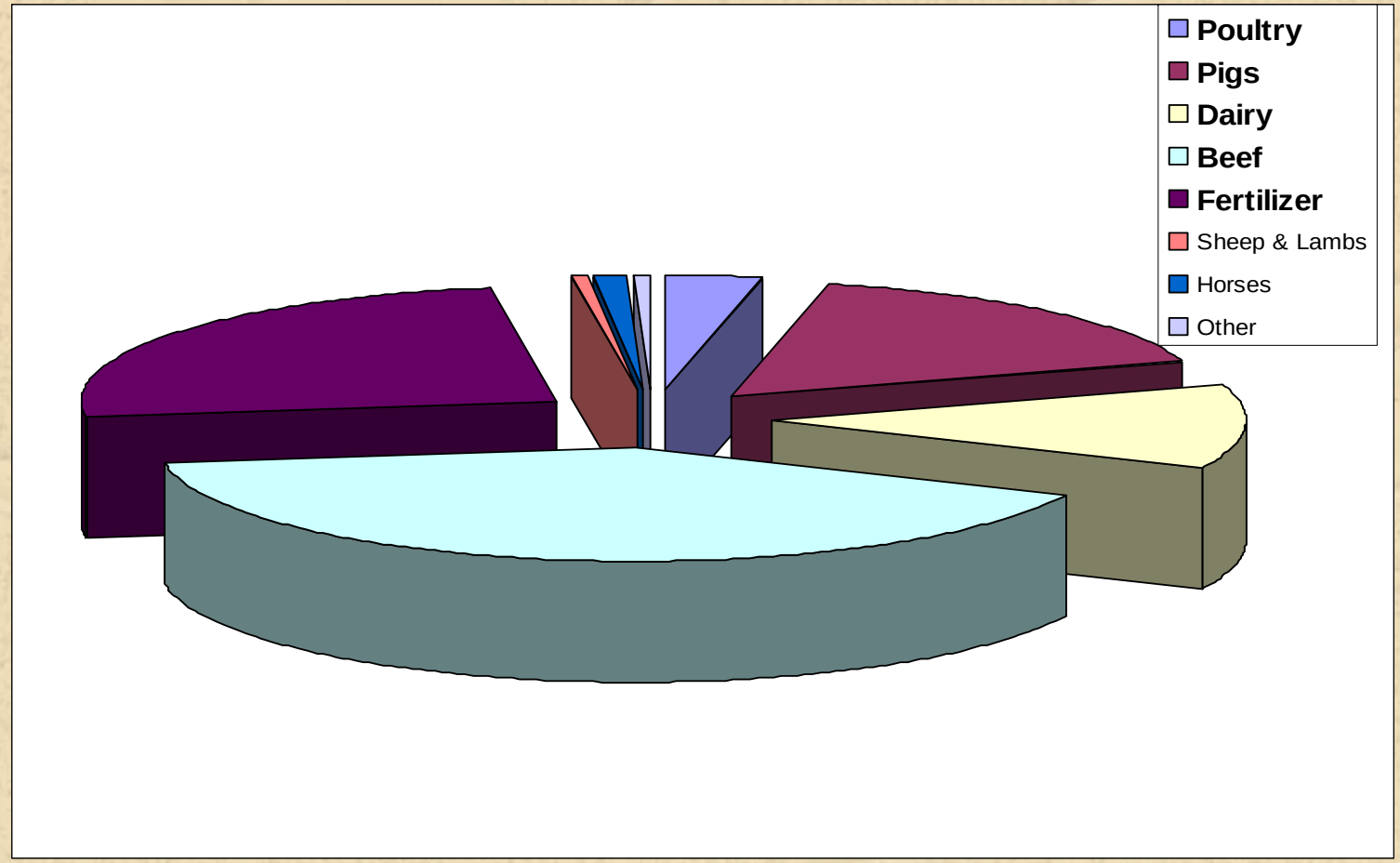
NH_3 Emissions by sector in Canada

Total = 511,000 t/ yr

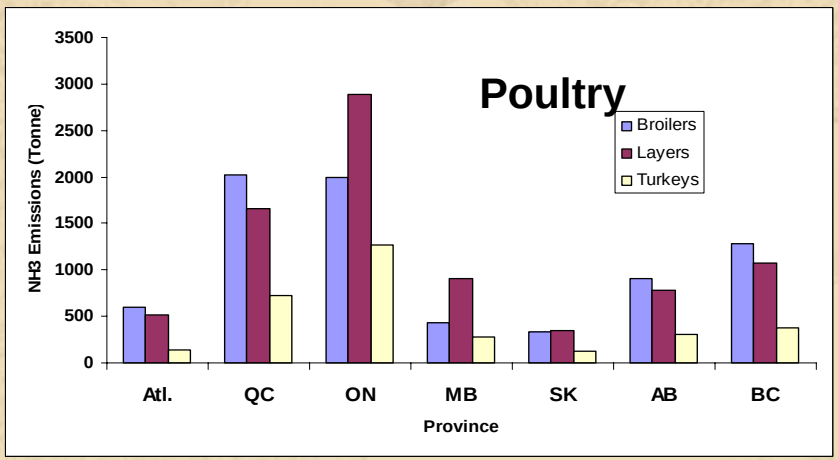


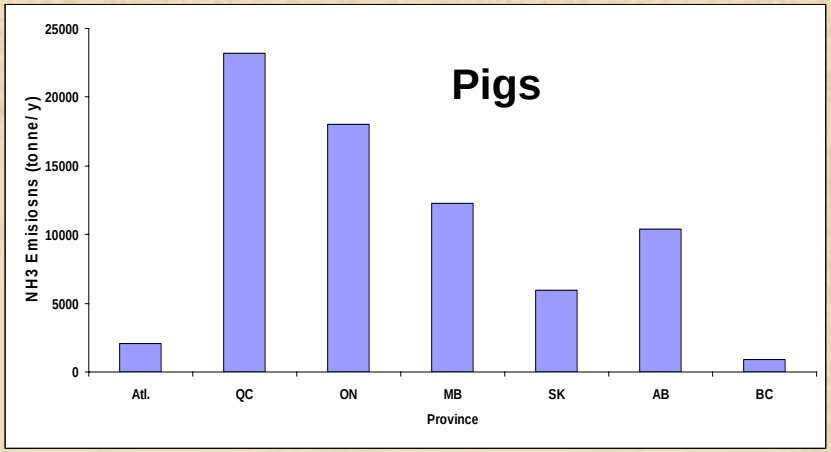
NH3 Emissions by agricultural sector

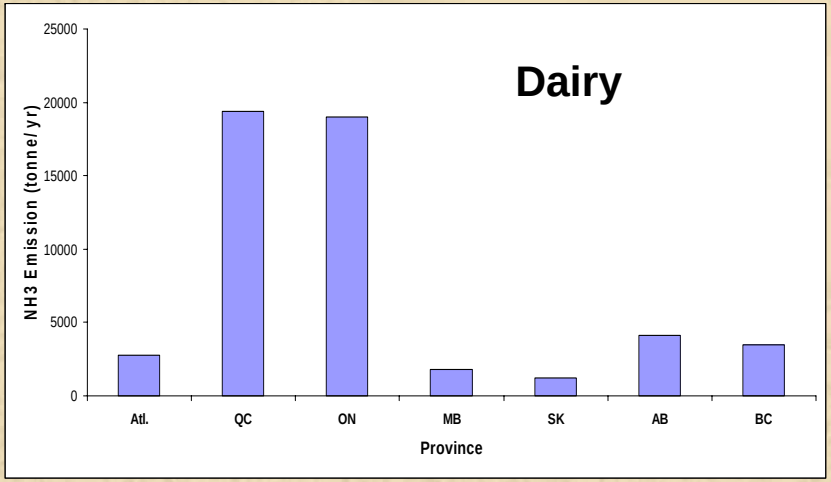
Total = 439,000 t/yr

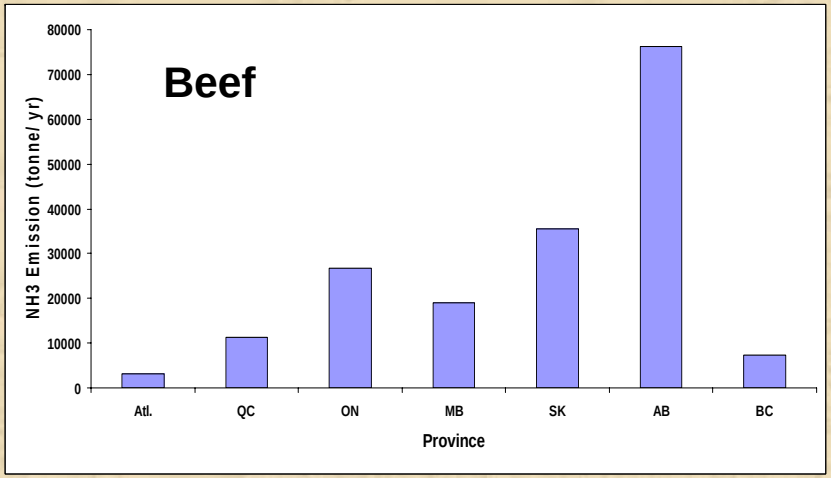


Annual NH3 Emissions from livestock sectors in Canadian Provinces

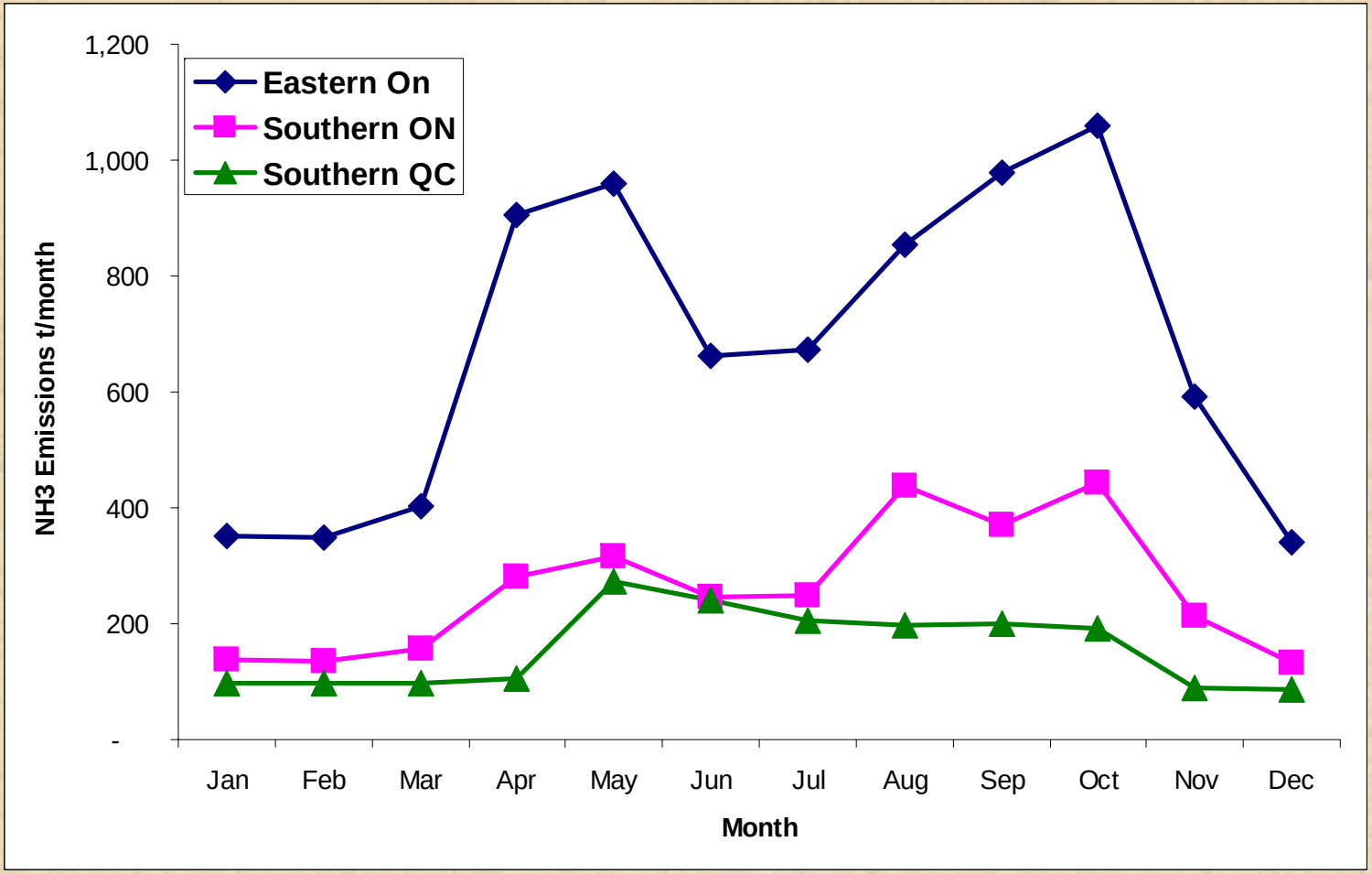








Monthly emissions from the dairy sector in three regions of Eastern Canada



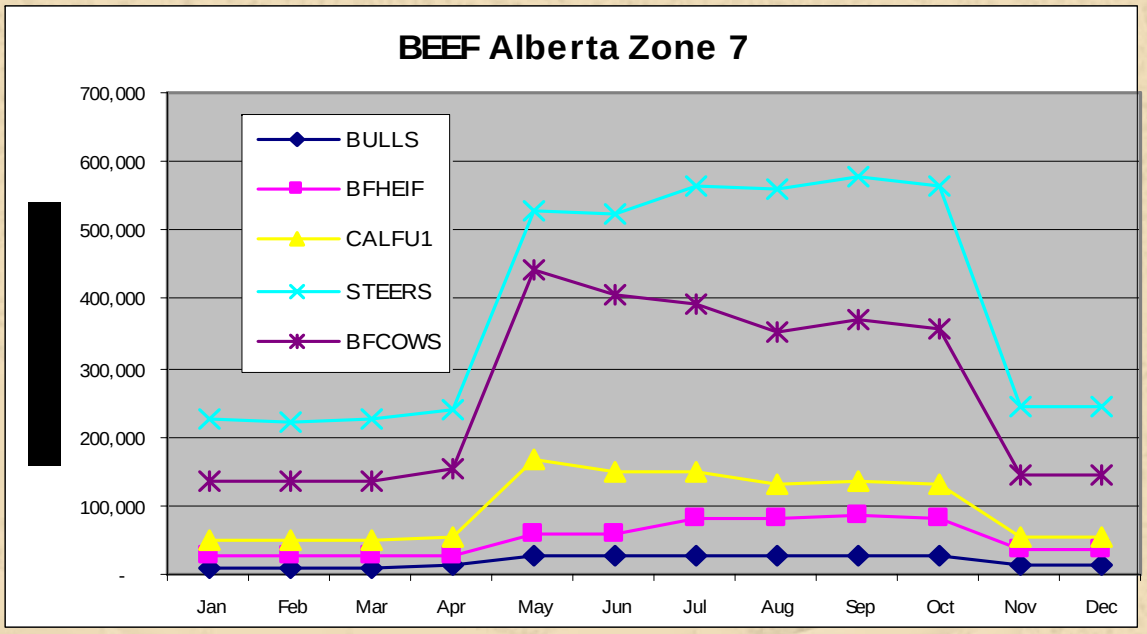
BEEF in Alberta

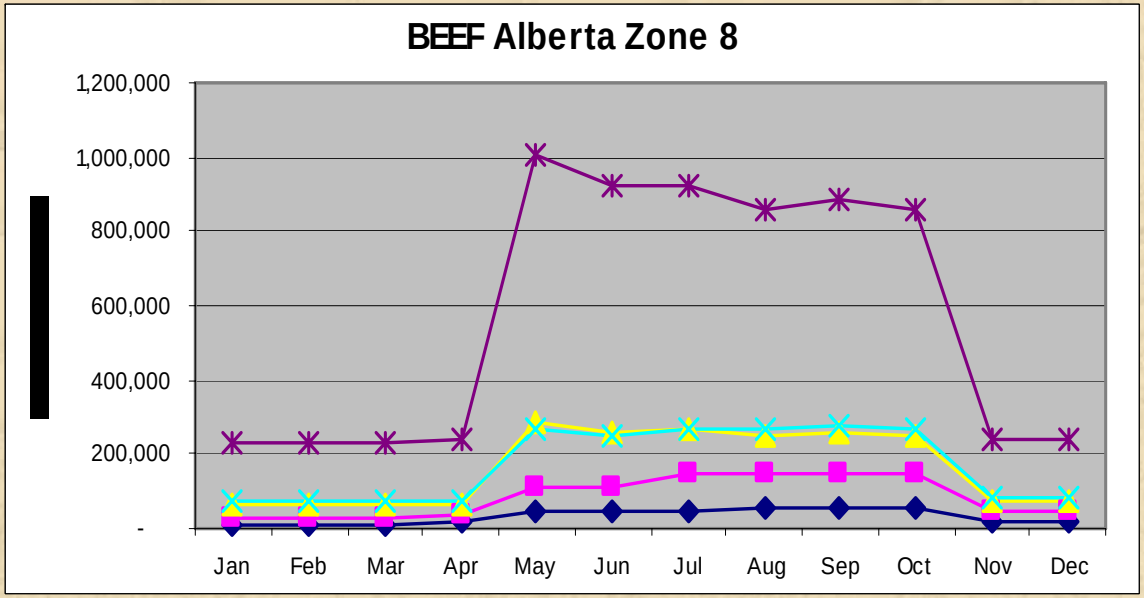
Zone 7 includes feedlots (finishing steers) and rangeland (cows)

Zone 8 includes cows and young steers

- Sharp increase in April-May is due to temperature increase and land spread

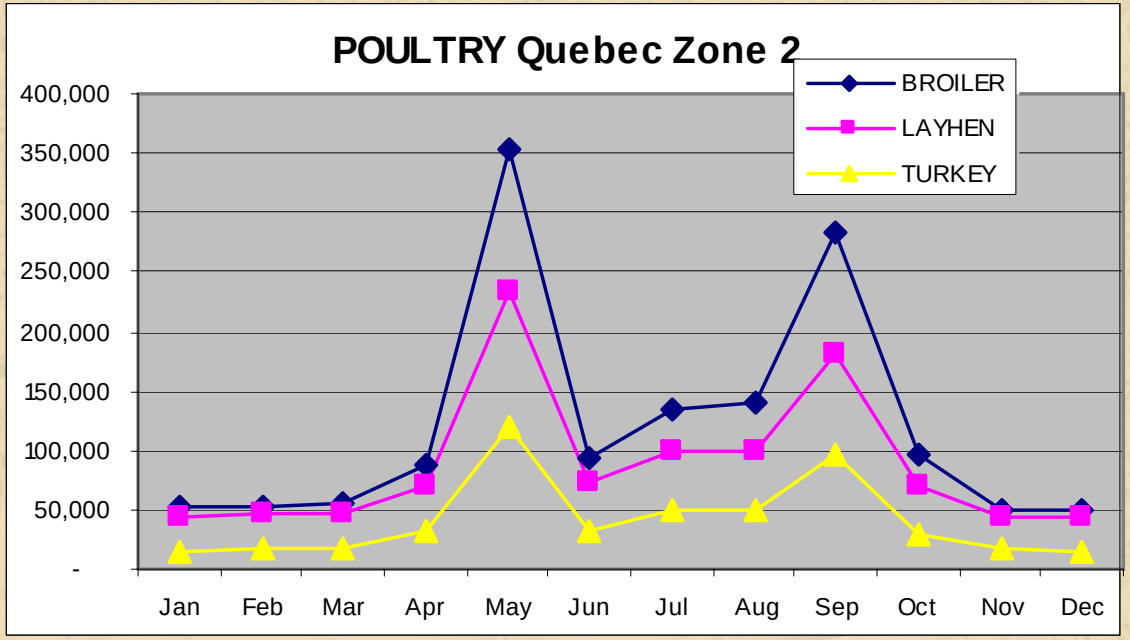
- Gradual decrease over growing season for cows reflects decline in grass quality on pastures.

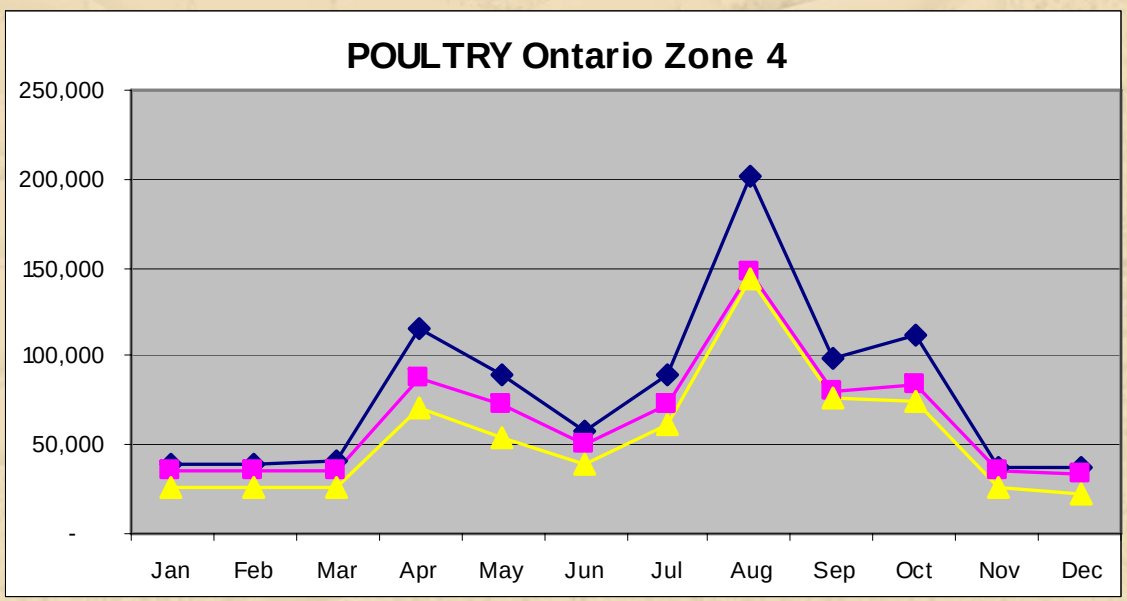




POULTRY in Quebec (2) and Ontario (4)

Peaks reflect contrasting land application practices. In two zones

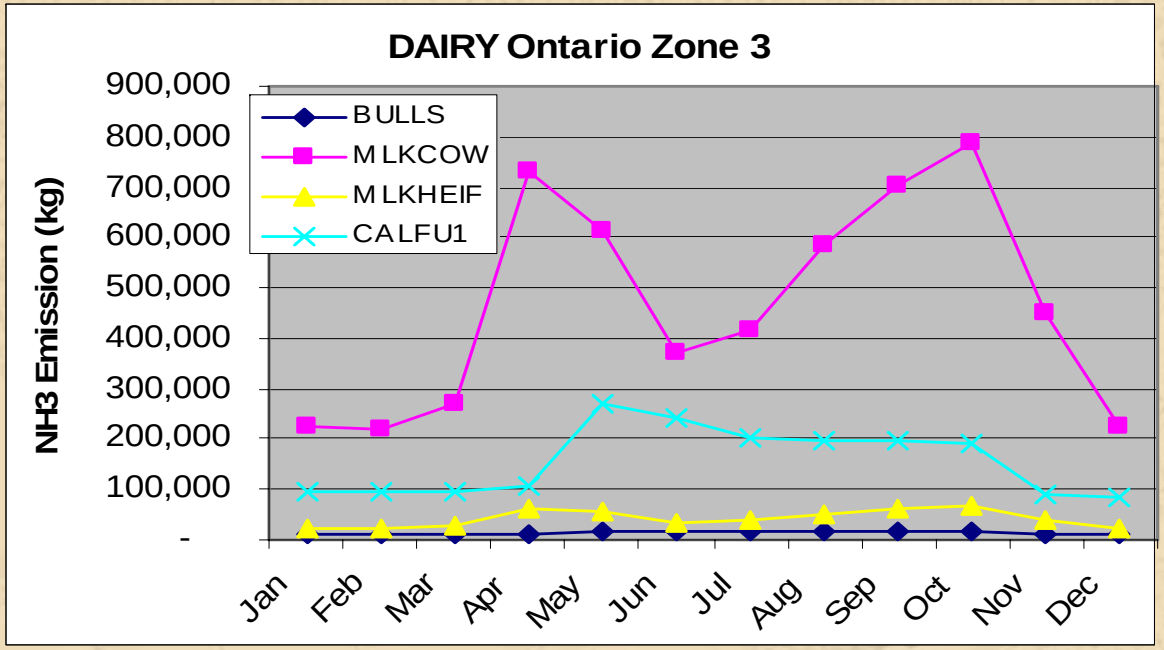


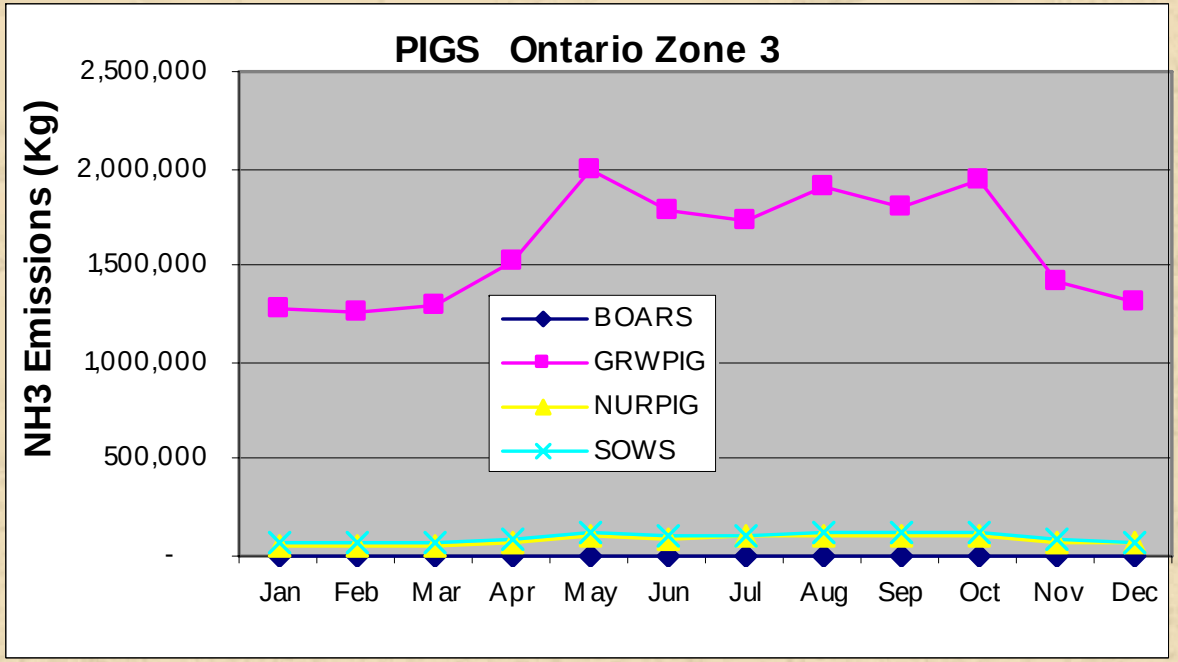


Dairy and Pigs in Ontario Zone 3

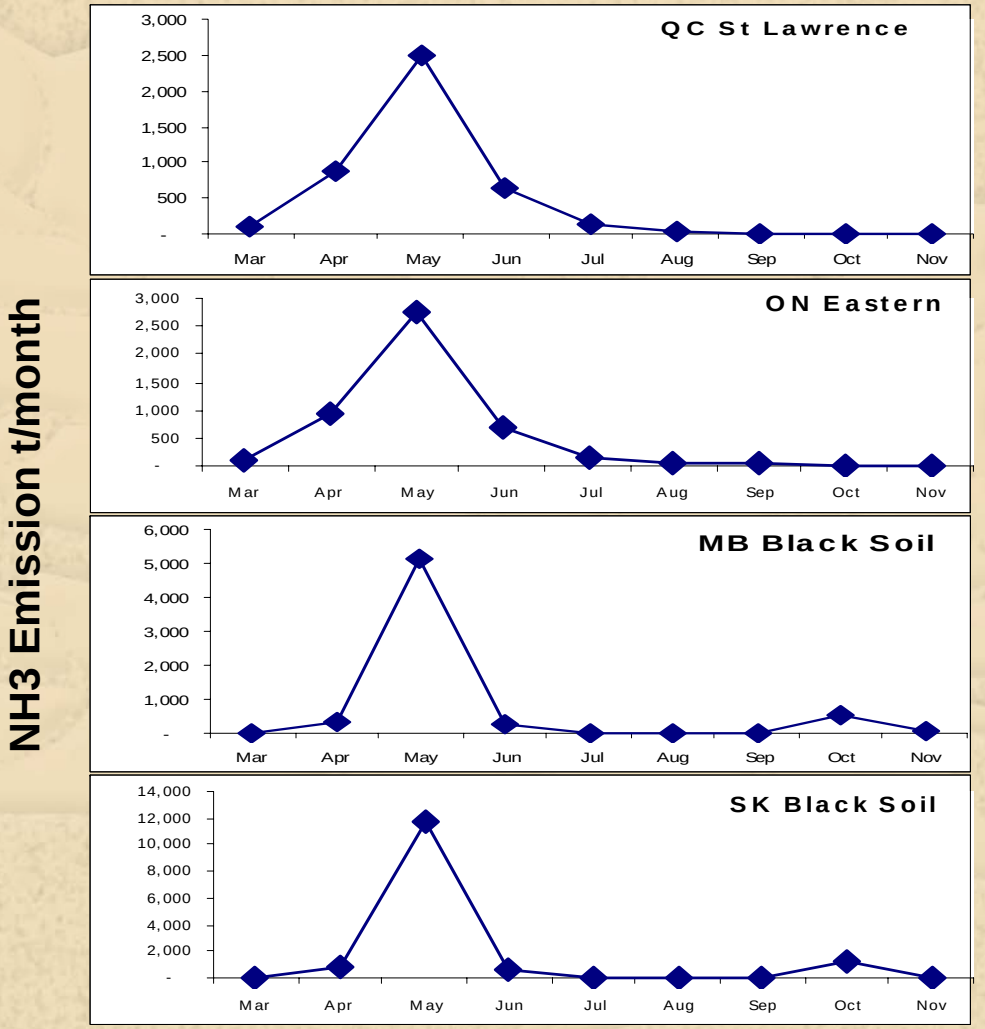
Dairy cows show double peak reflecting spring and fall manure application.

The pattern is less clear for pigs but reasons are not clear.



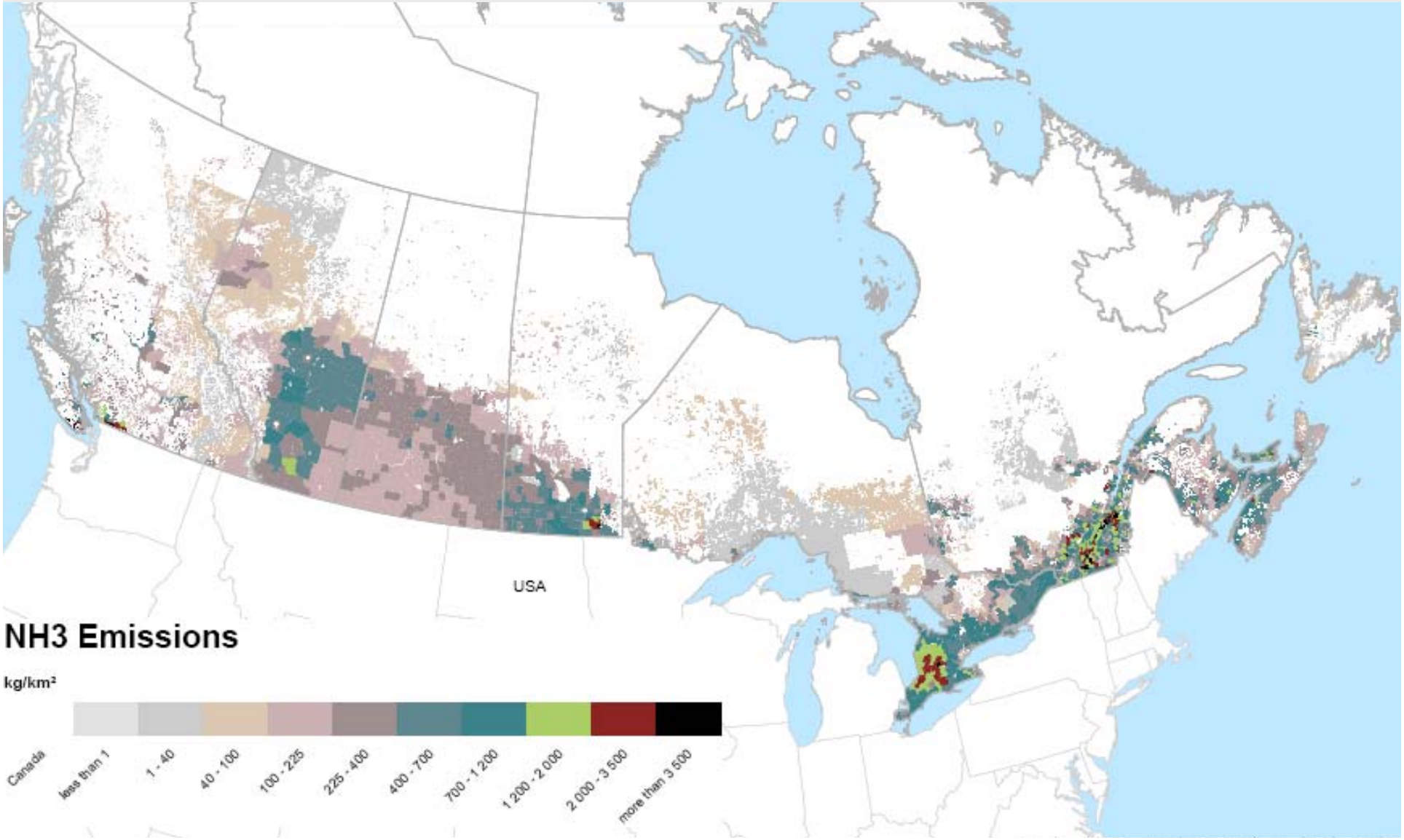


Monthly NH3 Emissions from fertilizers

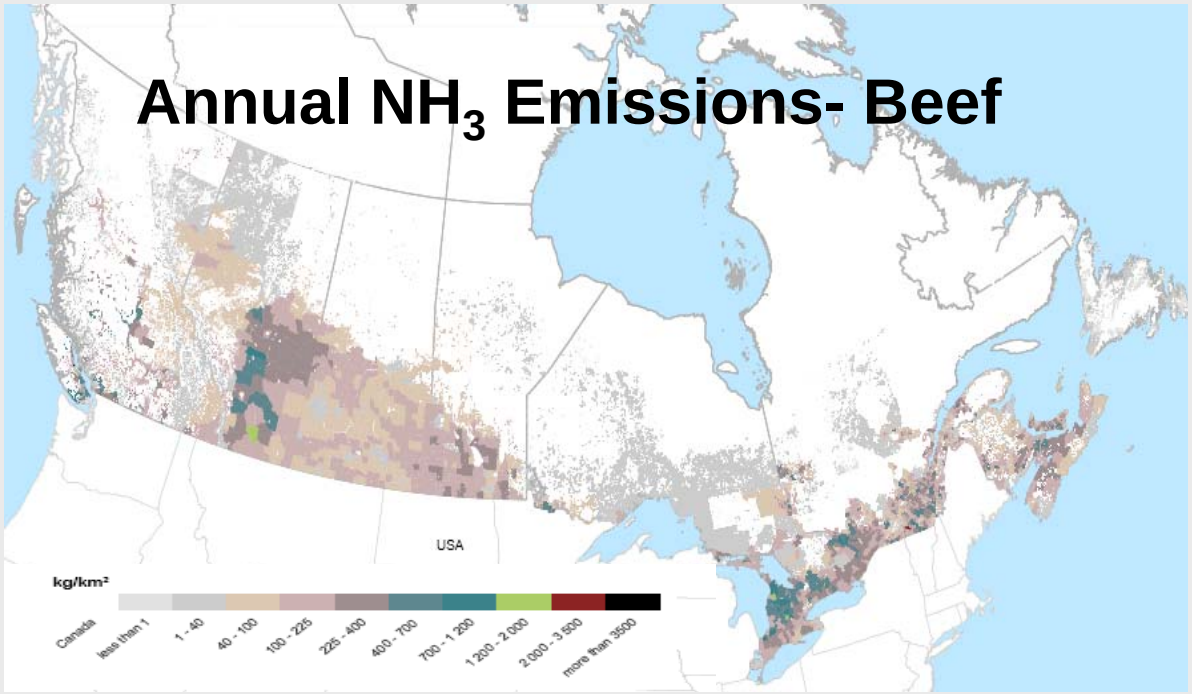


Annual NH_3 emissions all sources

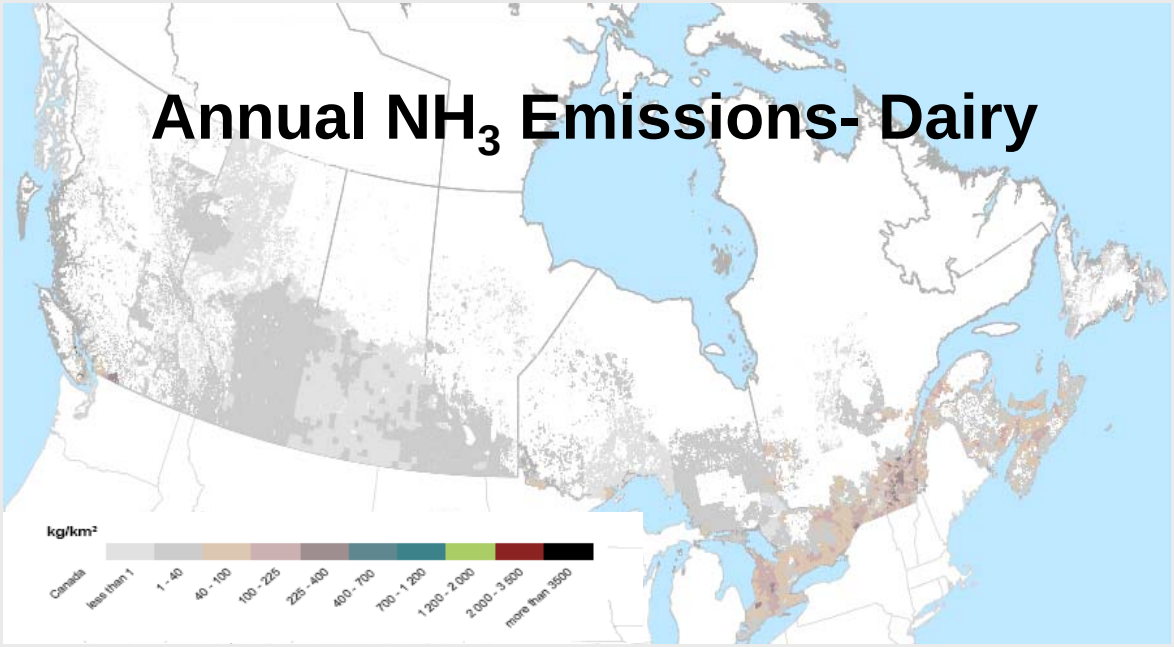
40x40 km grid



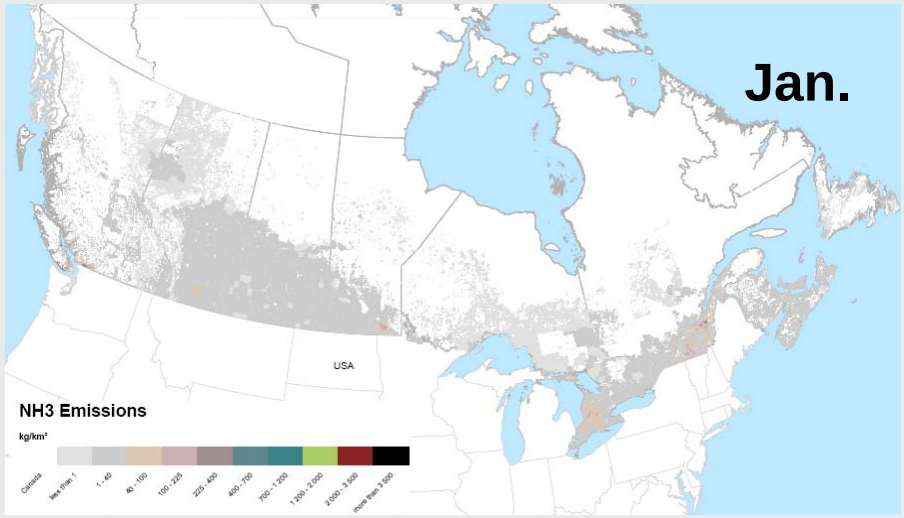
Annual NH_3 Emissions- Beef

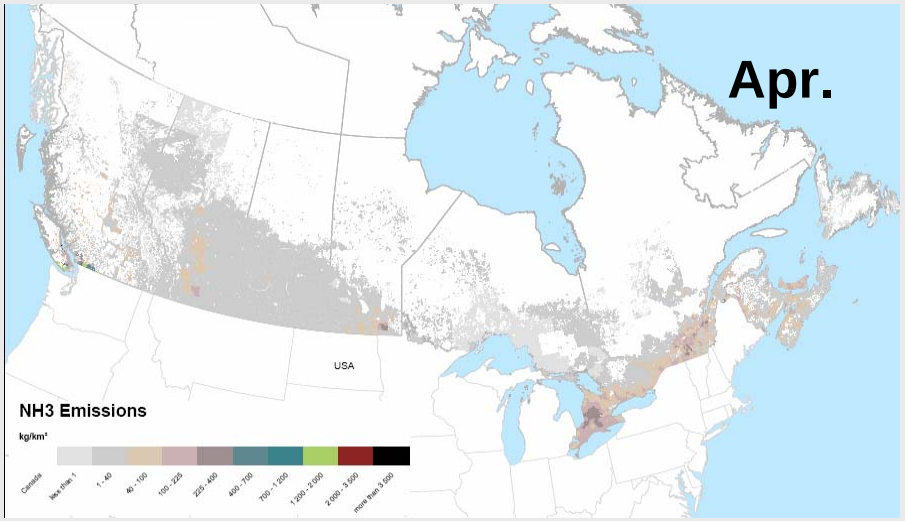


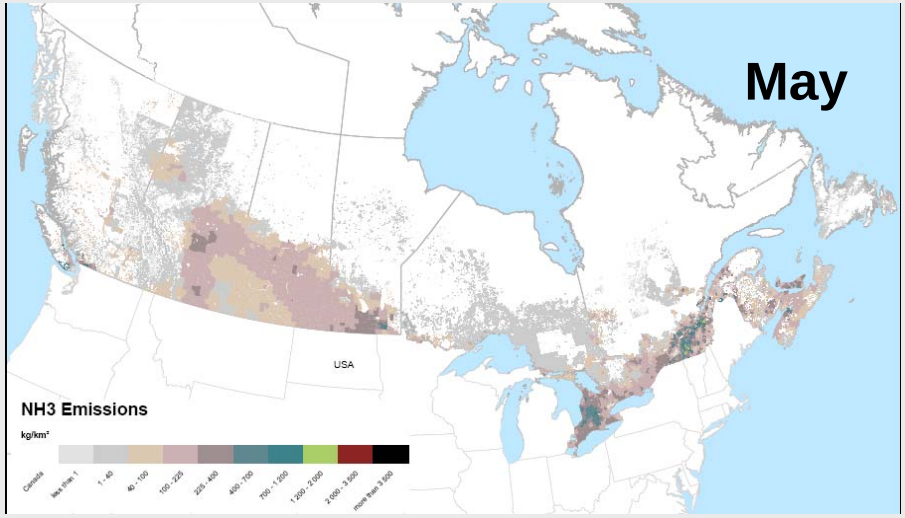
Annual NH_3 Emissions- Dairy

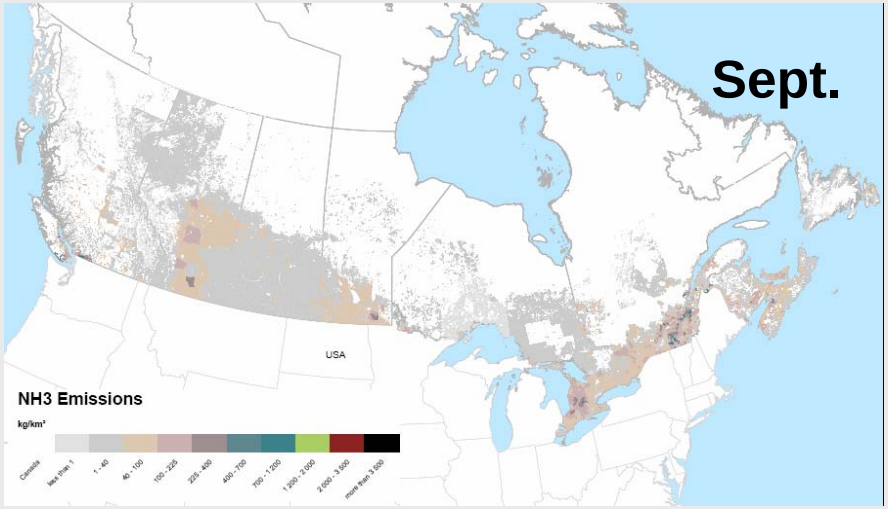


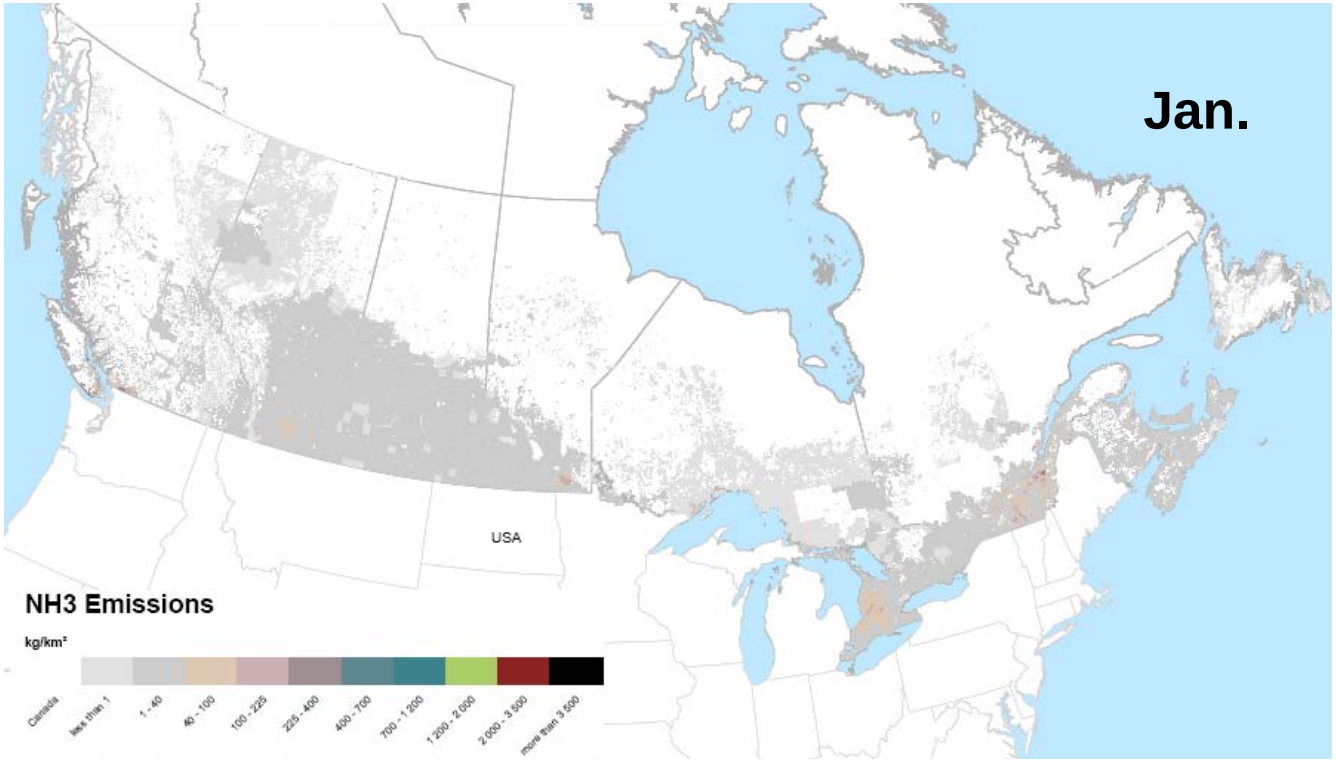
Monthly NH_3 emissions from all agricultural sources



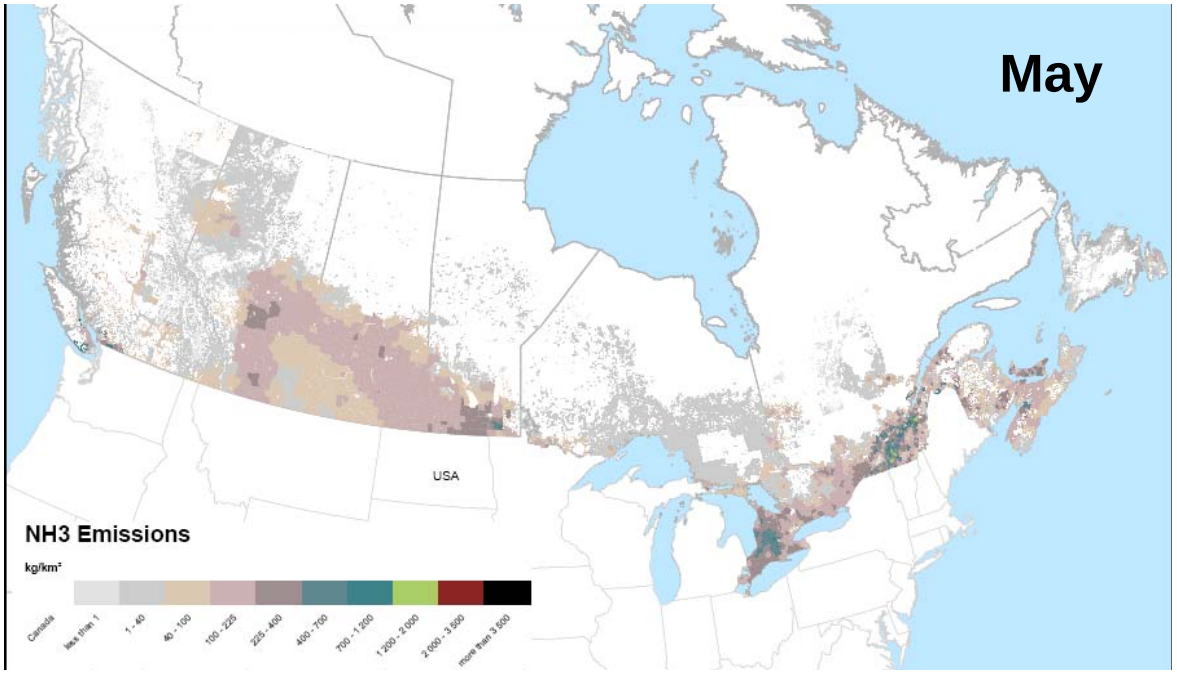








Monthly NH_3 emissions (all agricultural sources)



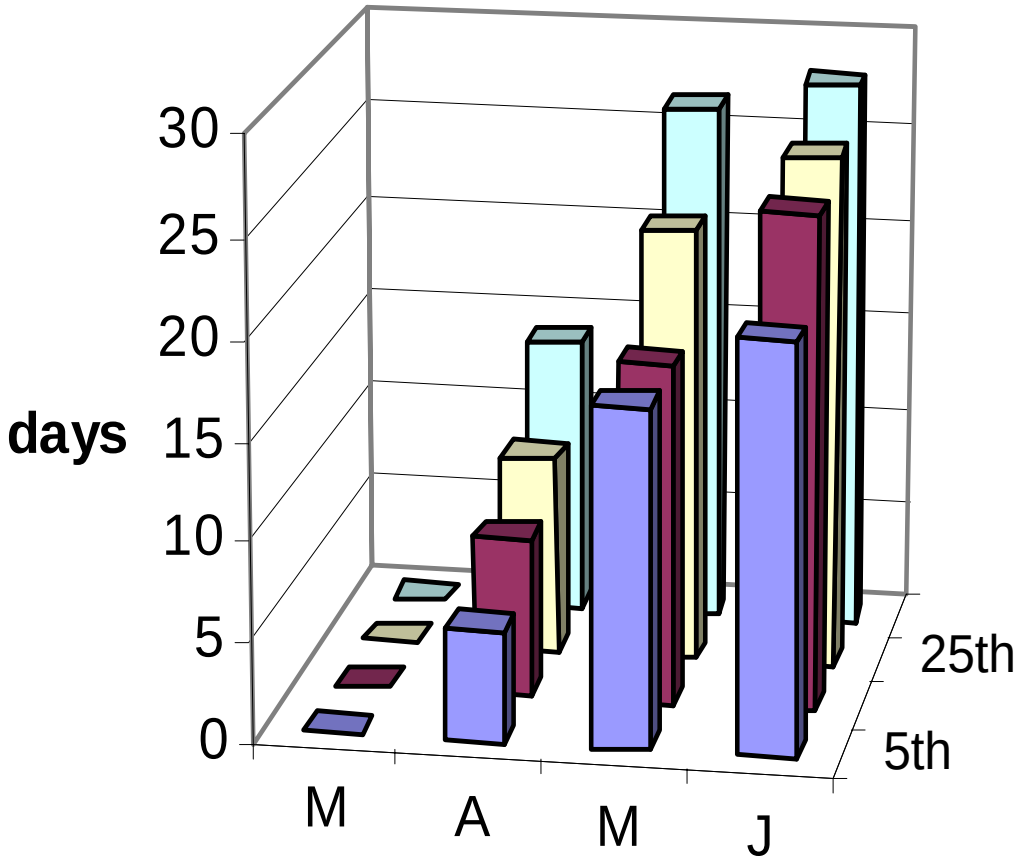
Effect of Frequency of Field Trafficability on Emission Intensity

Field trafficability based on 'Versatile Soil Moisture Model'

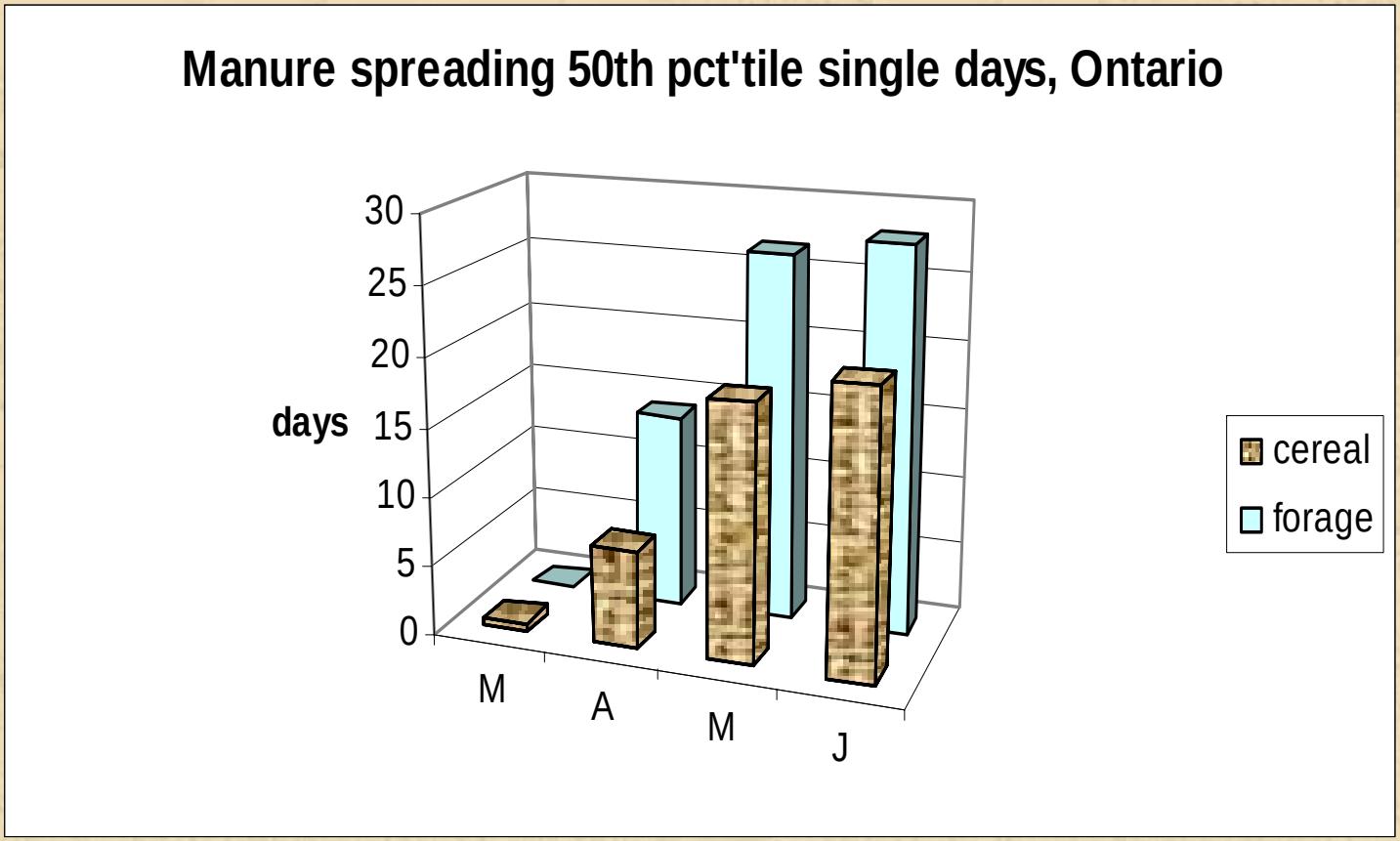
- **Based on rainfall, evapotranspiration and soil texture**

- ***No spreading if:***
  - **snow-covered**
  - **rains on the day**
  - **soil moisture too high to support equipment**

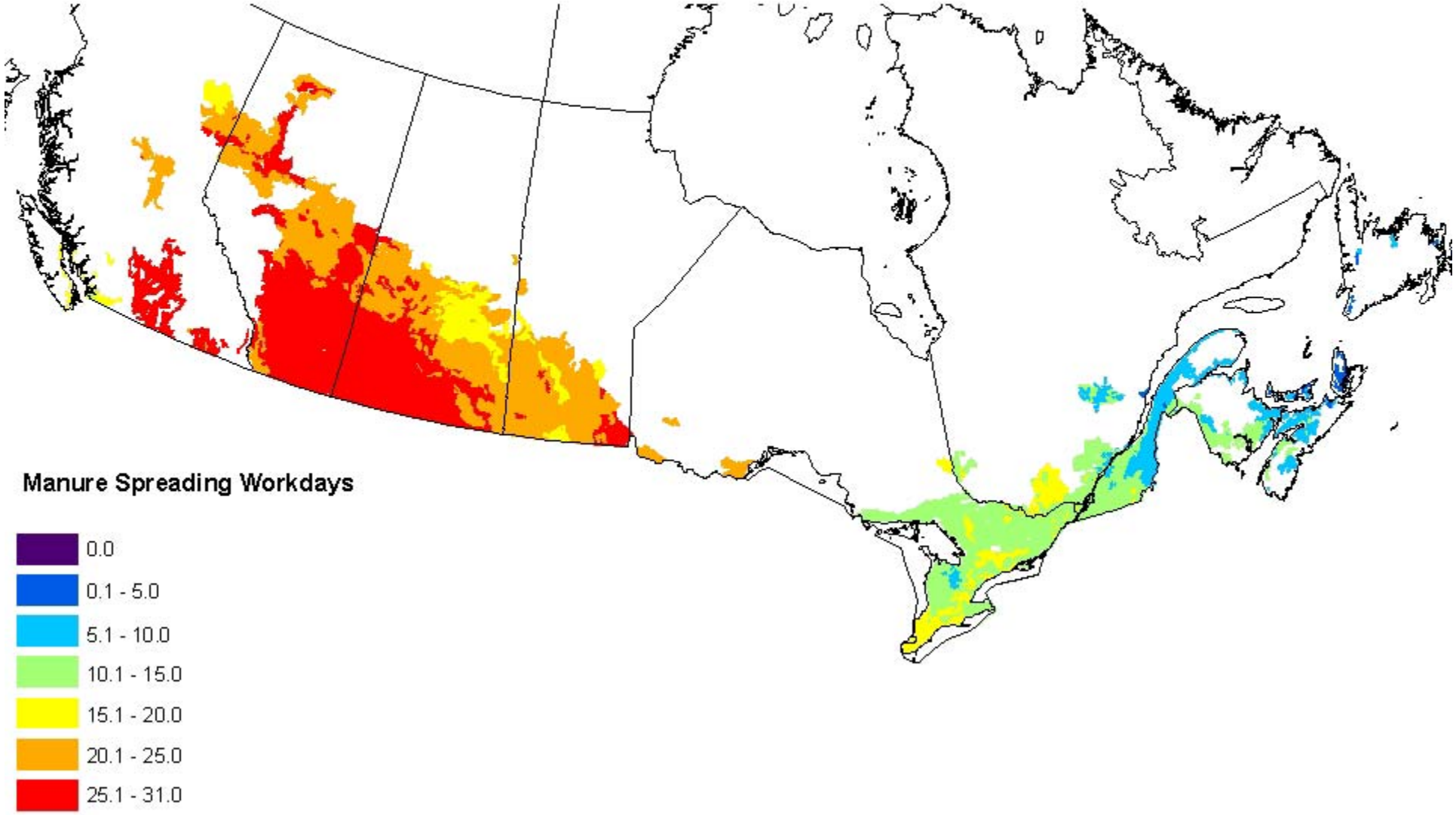
Manure spreading single days, forage, Ontario



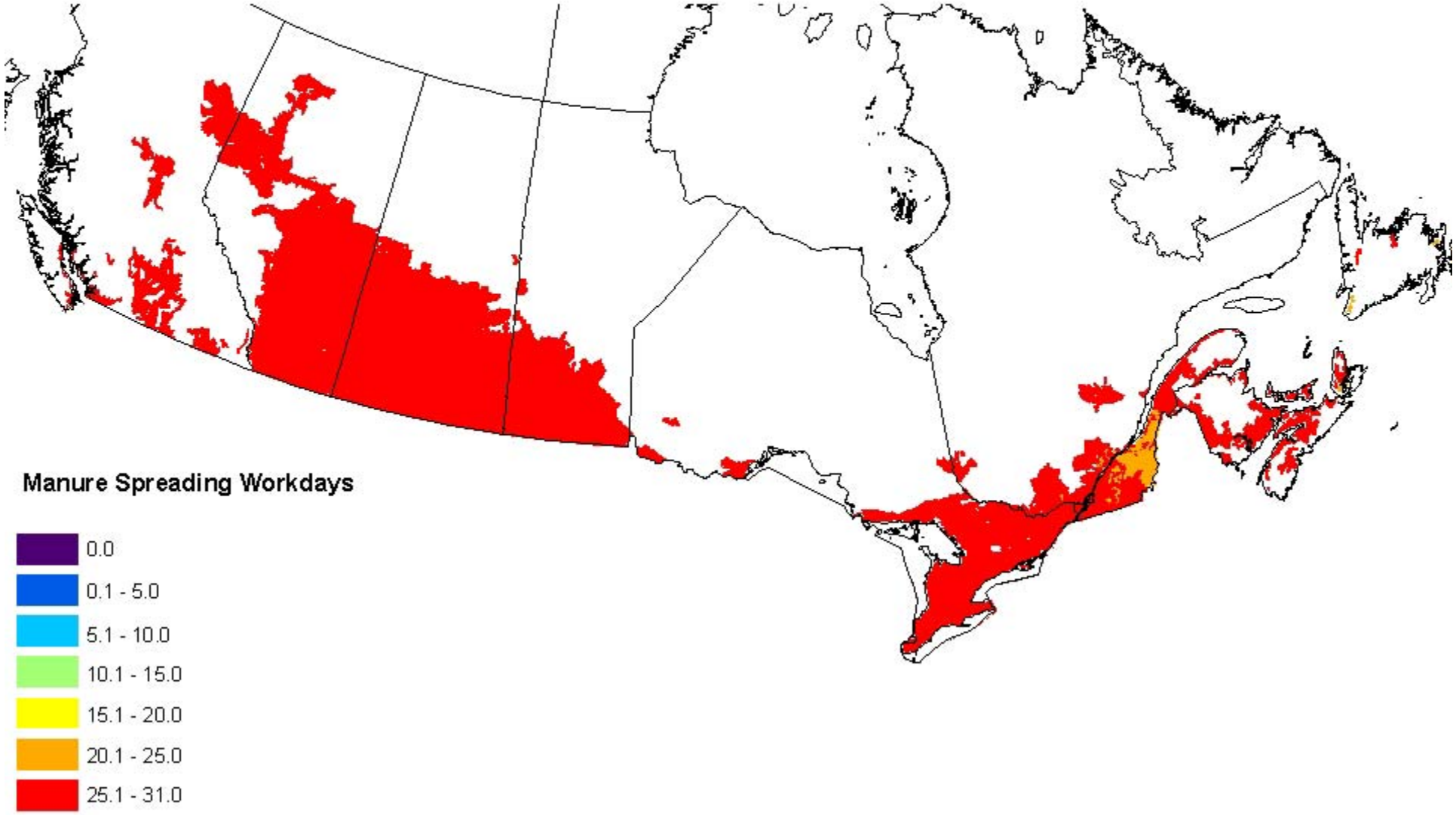
More working time on forage than arable (cereal) land



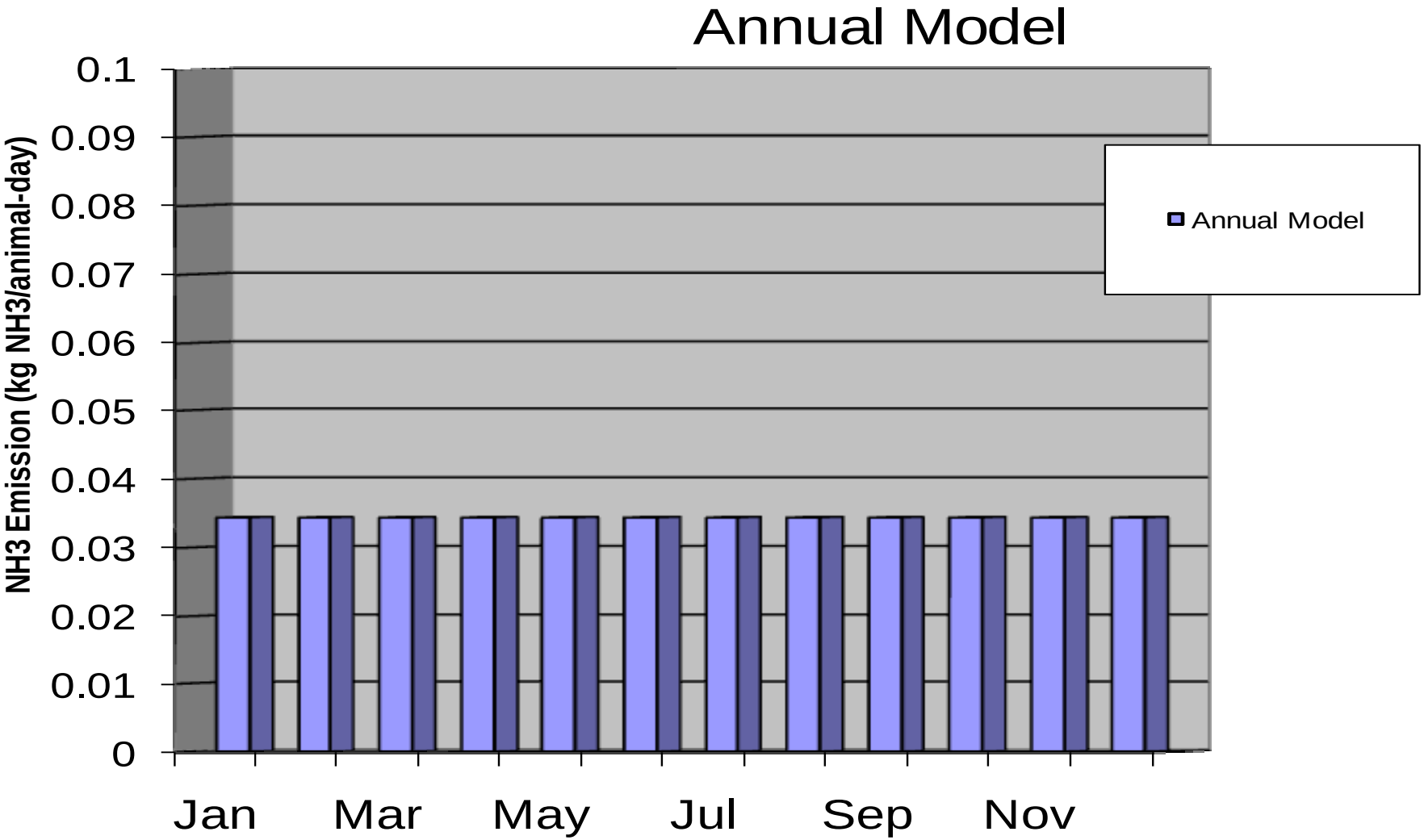
Manure spreading workdays on forages for April (days) (50% probability)



Manure spreading workdays on forages for June (days) (50% probability)



Daily ammonia emissions from dairy cattle using different models



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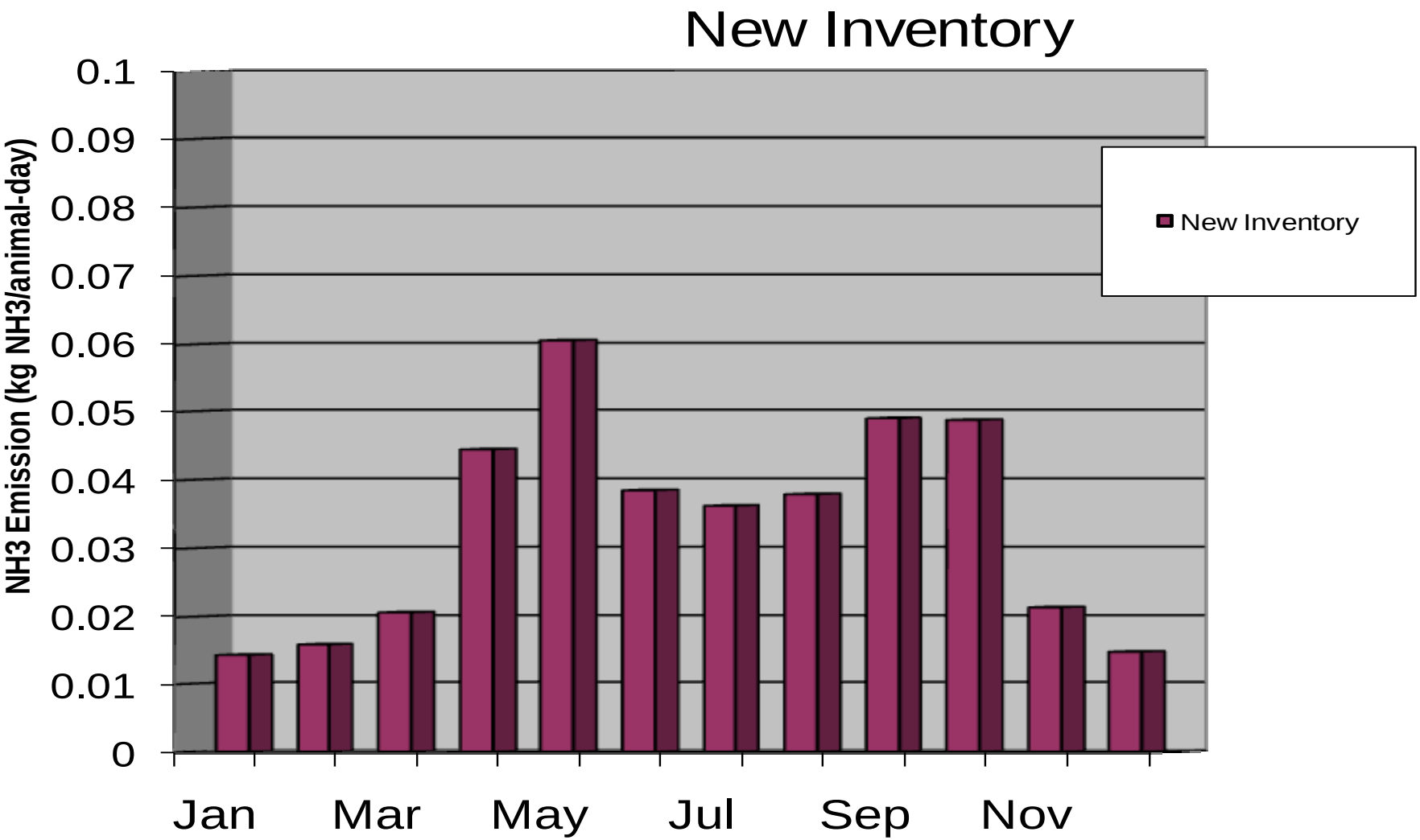

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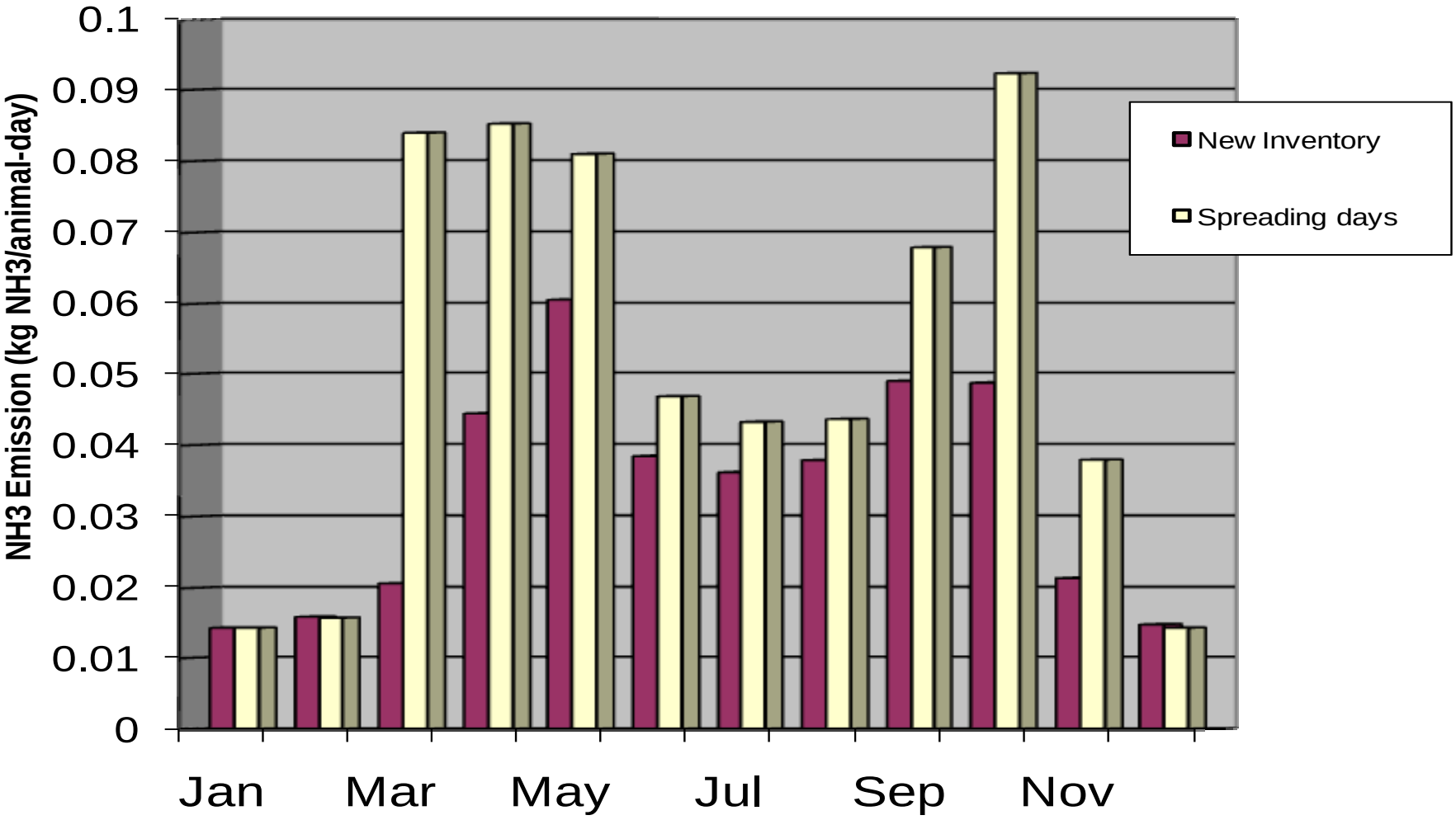
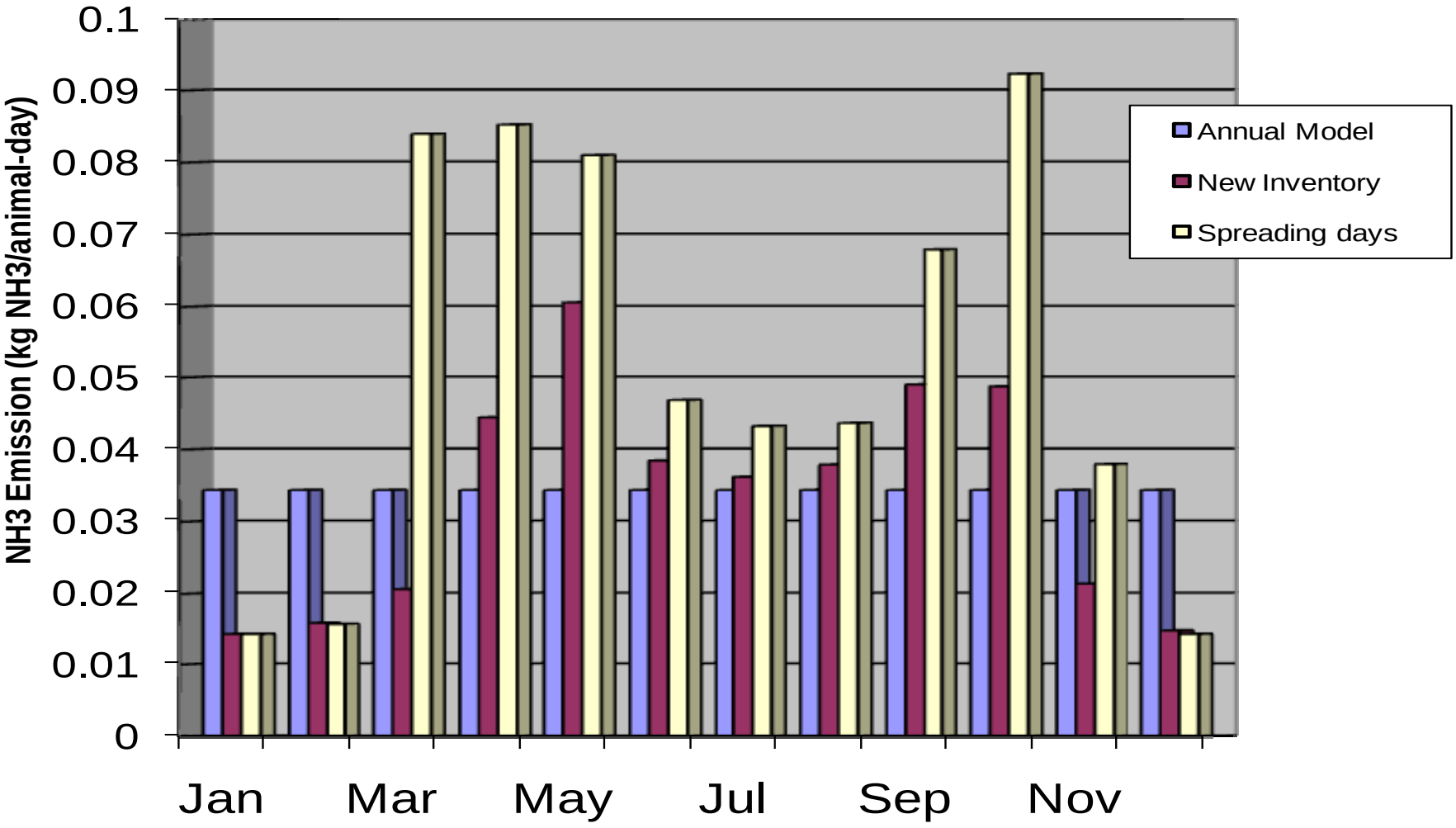


Daily ammonia emissions from dairy cattle using different models



Summary

- In ‘shoulder’ months (~April, ~October) there is a greater likelihood that landspreading will be focused into a few days of the month
- Flux on the non-spreading days would be comparable to winter values

Conclusions- General

- **Emissions are very sensitive to rates of excretion of urea, difficult to estimate for cattle**
- **TAN-flow emission inventories show central tendency because conserving in early phase will lead to more emissions later**
- **More work is needed on seasonal emission models and factors**
- **Local (dry) deposition may be significant factor but is ignored by inventories**

Conclusions- Canada

- **Largest emissions from beef, fertilizer, swine**
- **Hot spots- spatial:**

  south AB; south MB; Fraser Valley, BC; south ON; south QC
- **Hotspot- temporal: May (on manure and fertilizer spreading days)**
- **Ammonia loss ~ 1/3 N fertilizer input; implications for N balances?**
- **Results on impact of emissions and reduction scenarios are now being completed**
- **Abatement opportunities include protein ration for cattle, increasing manure injection/ incorporation, deeper manure storages and covers.**

Thank you

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J. Ayres Environment Canada

Funding

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