

Fate of pharmaceuticals and personal care products following land application of liquid municipal biosolids.



Ed Topp,
Agriculture and Agri-Food Canada,
London, Ontario, Canada.
toppe@agr.gc.ca



Co-authors

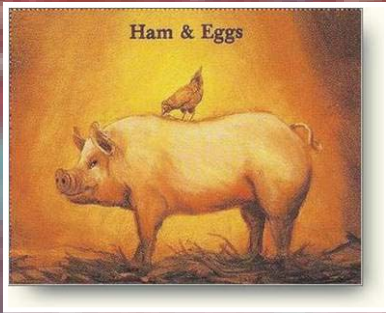
- Andrew Beck¹, Alistair Boxall², Peter Duenk³, Sonya Kleyvelt⁴, David Lapen⁵, Hongxia Li⁶, Chris Metcalfe⁶, Sara Monteiro², Michael Payne⁷.
- 1) Health Canada, Ottawa, ON, Canada
- 2) University of York, York, U.K. [ERAPharm]
- 3) University of Western Ontario, London, ON, Canada
- 4) Ontario Ministry of the Environment
- 5) Agriculture and Agri-Food Canada, Ottawa ON, Canada
- 6) Worsfold Water Quality Centre, Trent University, Peterborough, ON, Canada
- 7) Ontario Ministry of Agriculture, Food and Rural Affairs, Stratford ON, Canada.



Risk from:

- **Microorganisms.**
 - **Endocrine-disrupting chemicals.**
 - **Pharmaceuticals.**
 - **Nutrients**
-
- **Livestock and poultry wastes**
 - **Human wastes (municipal biosolids.)**

Exposure: Opportunities for managing risk



Assessing and managing exposure



This is not a BMP



Background

What is the environmental and human risk from these chemicals

- **Exposure**
 - **Some pharmaceutically- or endocrine-active substances are now found in the environment, but at very low concentrations.**
 - **Some of these substances are not removed during the sewage treatment process, and some may partition preferentially in biosolids.**
- **Impacts**
 - **The human and environmental health significance of this is unknown, but under investigation.**

Overall, the issue of these chemicals as 'emerging contaminants' is at a 'definition of problem' stage



Classes of agents of interest

- **Substances carried in human waste-municipal biosolids.**
 - **Pharmaceuticals, fragrances, antimicrobials, synthetic hormonal substances.**



PPCPs under investigation in field studies

- Acetaminophen Analgesic
- Naproxen NSAID
- Ibuprofen Analgesic
- Gemfibrozol Lipid regulator
- Atenolol Beta-Blocker
- Cotinine Nicotine met. Neutral
- Carbamazepine Anticonvulsant Neutral
- Fluoxetine SRI [prozac]
- Sulfapyridine Sulfonamide
- Sulfamethoxazole Sulfonamide
- Triclosan Antibacterial



Movement of PPCP to tile drains



Movement of PPCP to tile drains



Application over tile



Tile sampling pit



Macropore flow to tiles

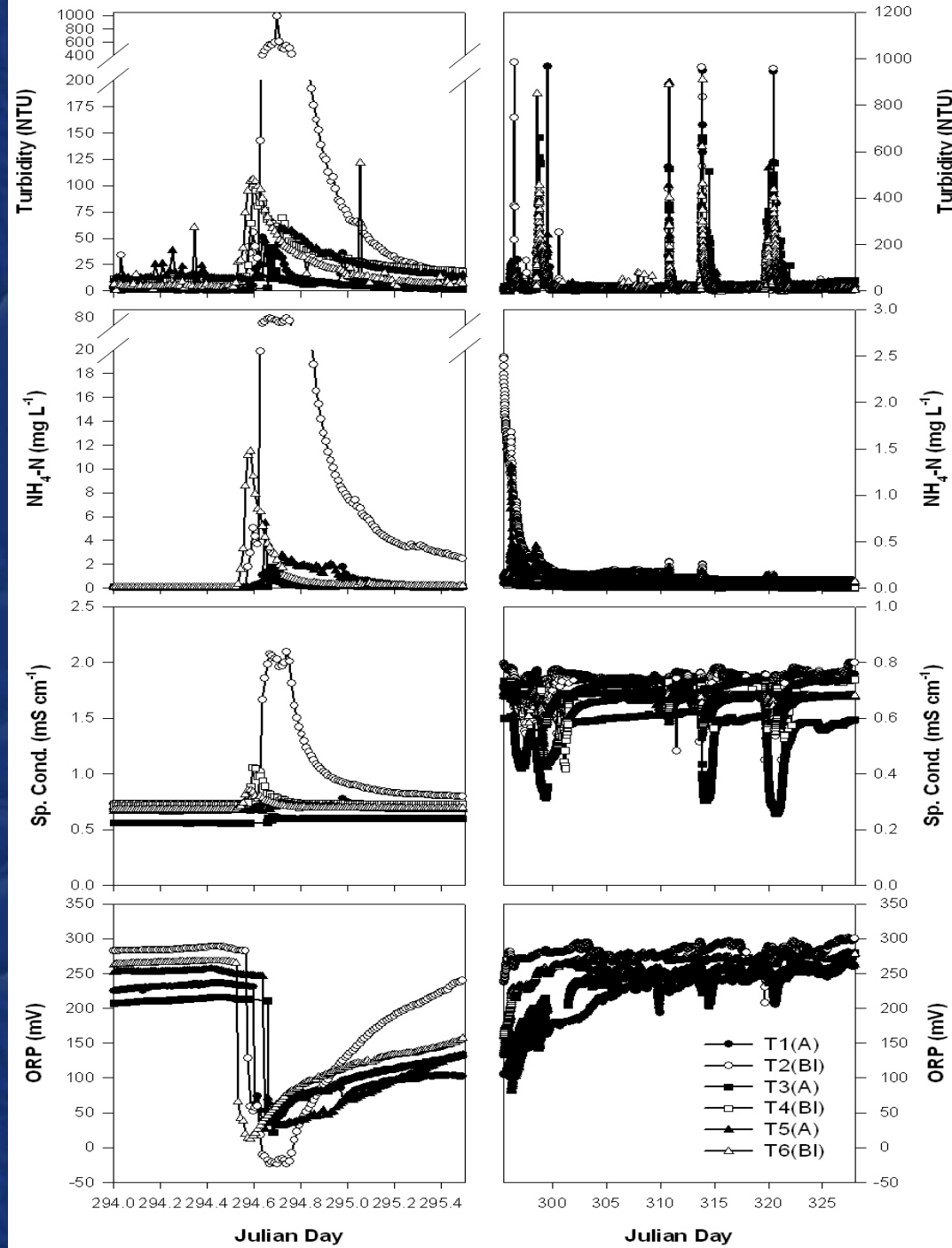
-Over 90% of flow to tile drains can result from macropores



Rapid movement to tile
at time of application.

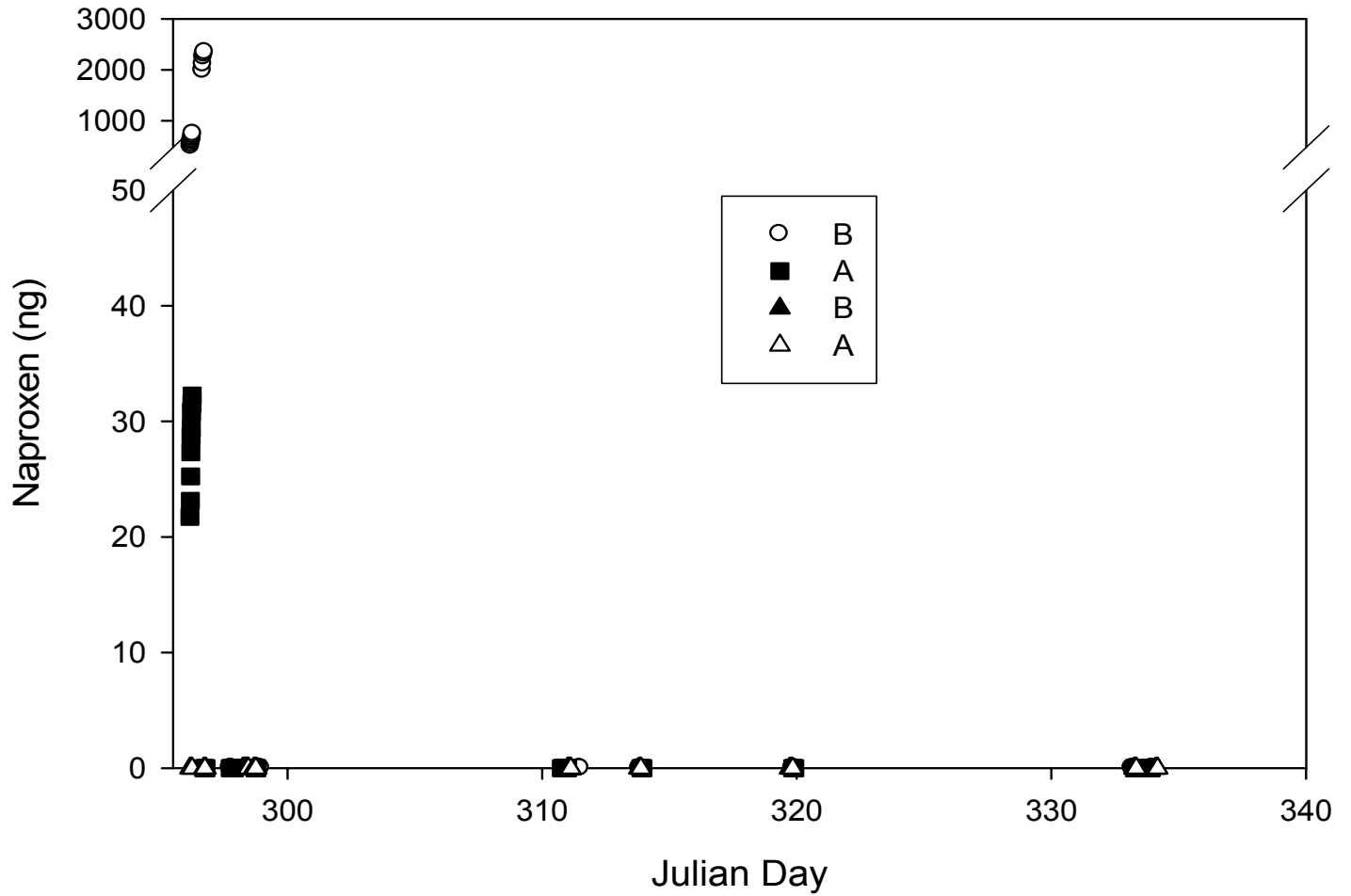
Periodic movement to
tile with subsequent rain
events.

Turbidity, ammonium
and bacteria
[not shown here]
indicate macropore
flow.

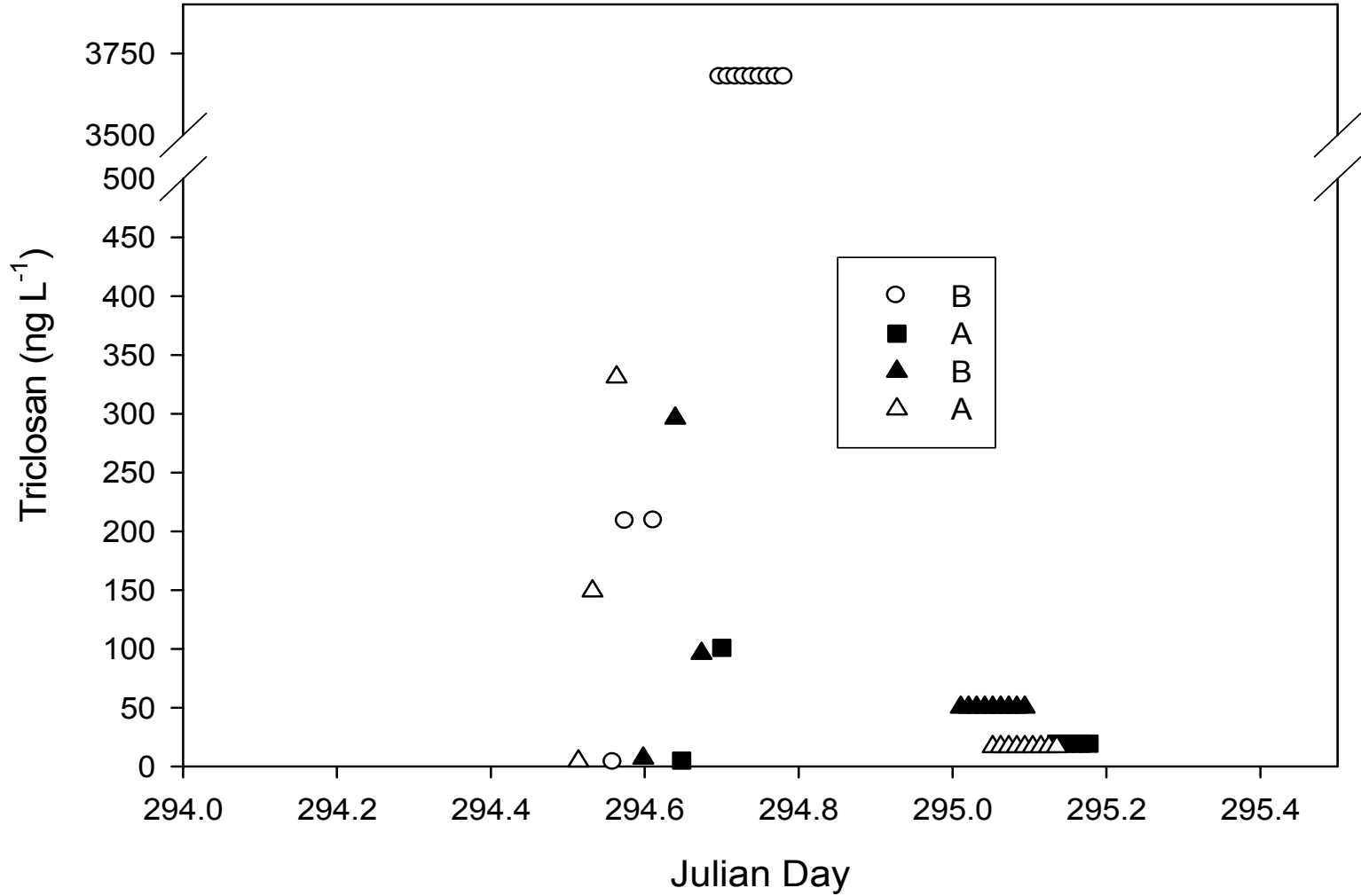


All export associated with the first event

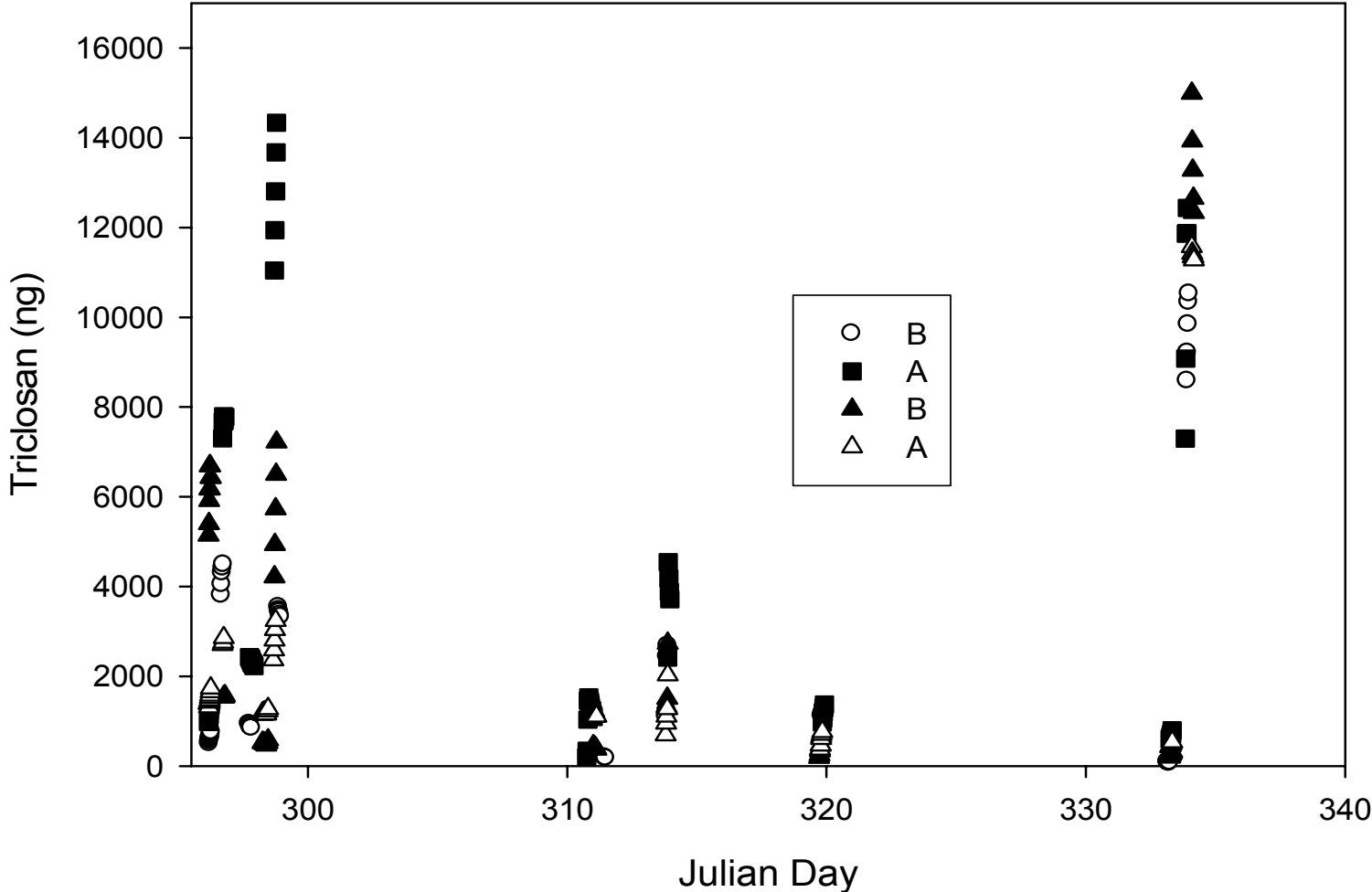
Naproxen output (per 15 minute interval)



Triclosan



Triclosan output (per 15 minute interval)



Runoff potential





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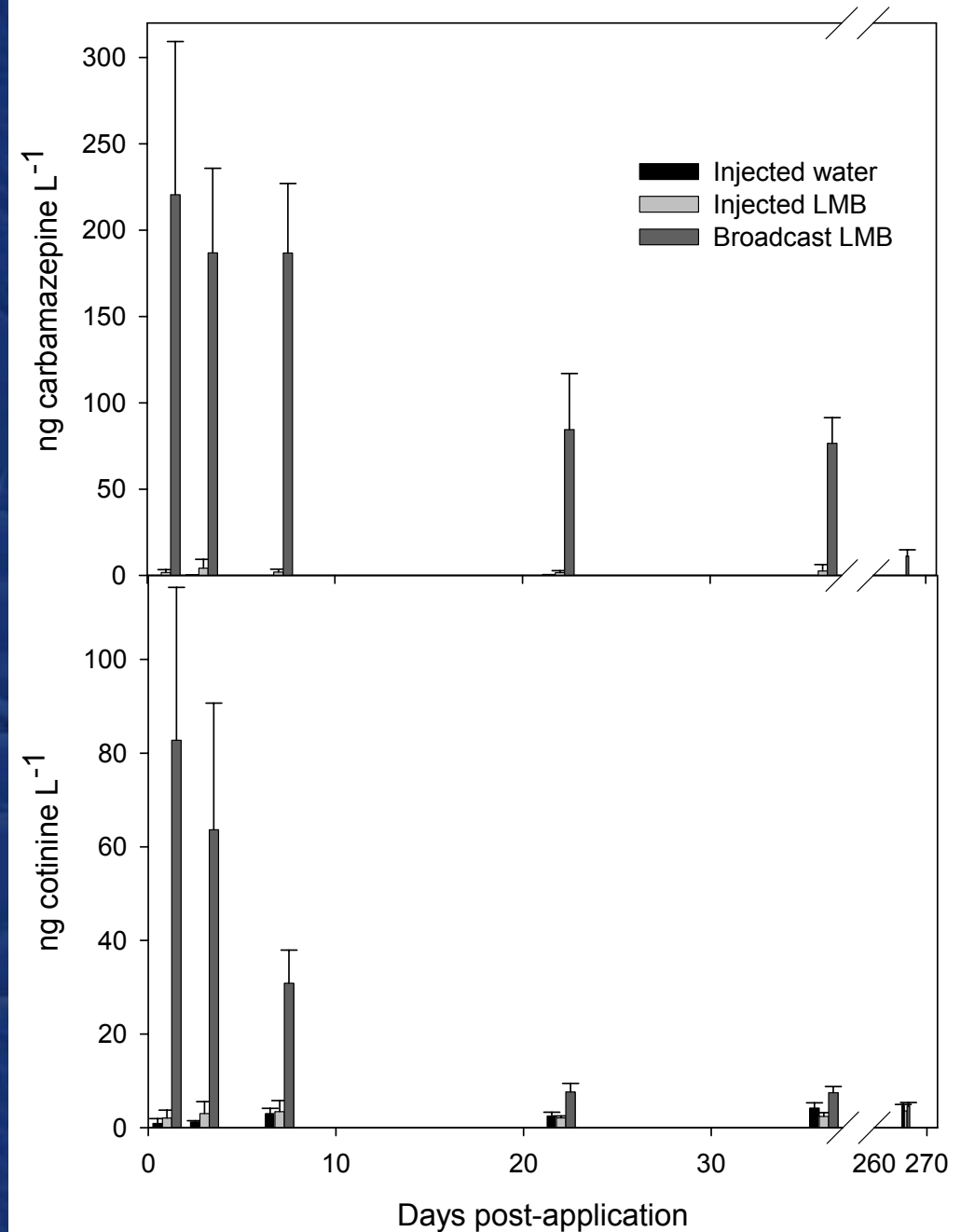
Canada

Striking effect of depth of placement.

First order kinetics of decline.

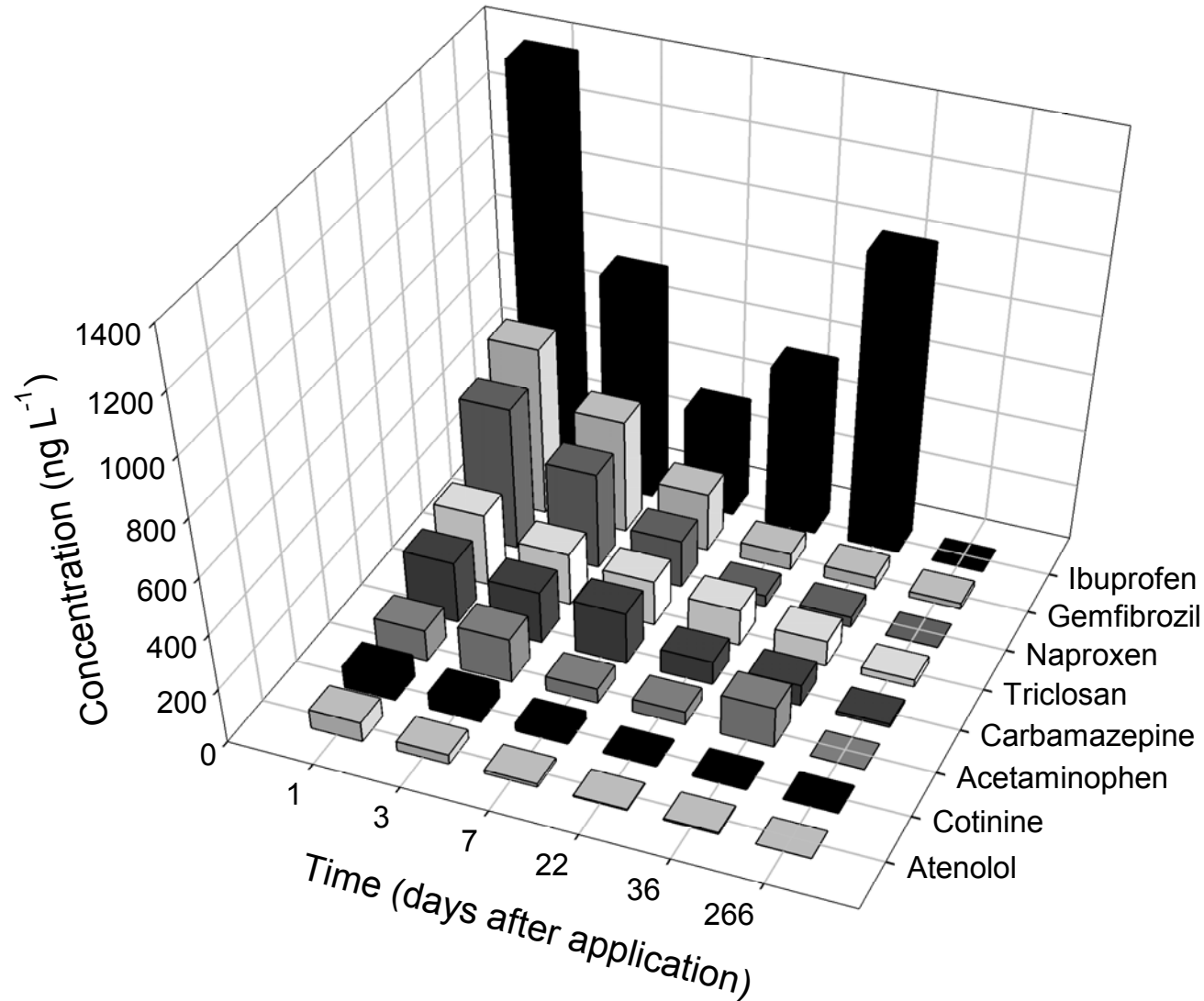
Variability modest.

Detection over winter



5 key observations

- runoff concentrations are in ppt or in case of ibuprofen ppb range
- Generally first order loss of materials post-application.
- but kinetics don't hold at low concentration end
- Carbamazepine, triclosan and gemfibrozil detected after winter.
- acetaminophen and (especially) ibuprofen have unusual concave Kinetics.



A rough comparison of annual environmental loading of selected ECs from biosolids use and sewage outflows in Ontario

- Ontario population 13 million.
 - Assumptions for land application
- 2000 ha/yr receive commercial rates of liquid and dewatered. In Ontario apply equiv of 60000 tonnes OC per year.
- Concentrations of drugs in this material, our own data and literature (eg. Kinney et al. 2006 Environ. Sci. Technol.)
- We use our simulated runoff to represent the worst case scenario.
 - Assumptions for sewage outflow
- Numerous literature studies document range of drug concentrations in sewage outflows.
- Estimated 500 billion liters of sewage outflow released into Ontario per year.



Annual release in kg

- **Compound**
- **Carbamazepine**
- **Ibuprofen**
- **Sulfamethoxazole**
- **Triclosan**
- **Land/outflow**
- **0.8/110-172**
- **4.2/37.5-942**
- **0.1/435**
- **0.9/31.5**



Conclusions

- These chemicals vary in their persistence, need to consider on a case by case basis.
- Concentrations of chemicals in runoff are generally very low.
- Key exposure risk is at or shortly after the time of application.
- Application can be managed to reduce application-driven transport, reduce risk of runoff.
- Relative environmental exposure via biosolids application compared with sewage effluent.

