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Soil Toxicity Test Method Development and Collaboration with the Tri-national Initiative

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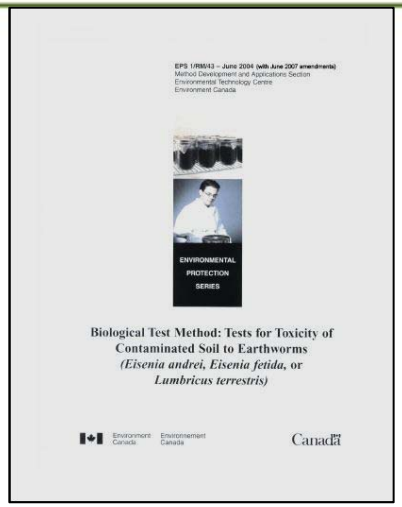
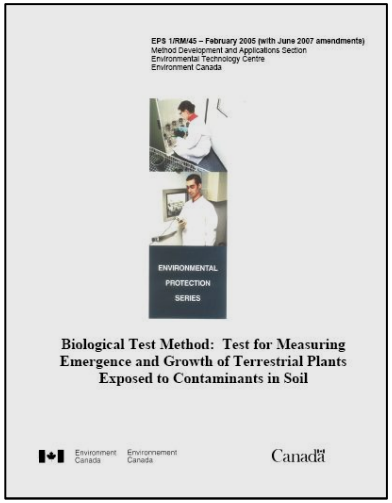
Mandate

- Biological Methods Division
  - Develop and apply biological test methods for the assessment of individual chemicals and contaminant mixtures on soil invertebrates, terrestrial plants, soil function and microbial communities in soil
    - In-house research jointly shared between the Soil Toxicology Laboratory (Juliska Princz) and the Soil Biotechnology Laboratory (Lee Beaudette)
  - To validate and standardize biological test methods using aquatic, sediment, and soil organisms; and develop supporting guidance documents for use in Environmental Protection programs
    - Delivered through the Method Development and Applications Section (Lisa Taylor)

Background

- Environment Canada (EC) has published three soil toxicity test methods
  - 2004 – Earthworms (survival and reproduction)
  - 2005 – Plants (seedling emergence and growth)
  - 2007 – Collembola (survival and reproduction)
- Level of effort
  - Average of 10 years for initial method development, validation and standardization
- Applicability
  - current methods were designed for use in assessment of agronomic systems using suitable and relevant test species
- Program Priorities
  - Federal and provincial contaminated sites; Chemical Management Plan, Canadian Environmental Protection Agency (CEPA) New Substance Assessments

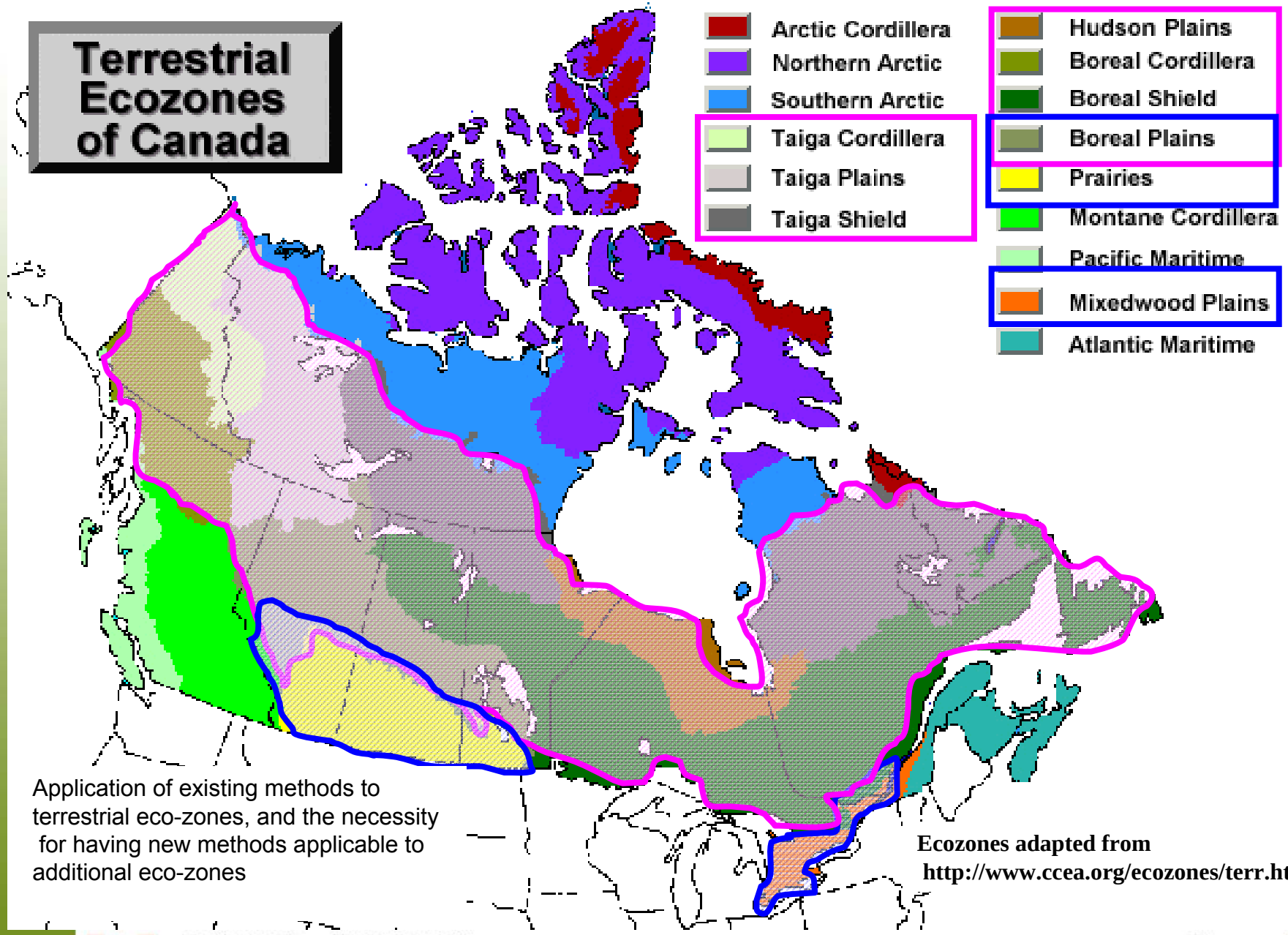




Background

Environment Canada 2003 Soils Workshop

- Workshop held to identify research priorities for development of standardized biological methods for the assessment of contaminants in natural soils across Canada
  - **Major Workshop Outcome** – Development of a 2 generation of standardized soil toxicity test methods using test species reflective of boreal and taiga eco-zones
    - Use ecological relevant species and effective microbial assessment tests (e.g., woody & herbaceous plants, soil invertebrates, microbial functional and community assays)
    - Development of tools applicable to contaminated land risk assessment and management (e.g., assessment of contaminated industrial lands and performance of remediation technologies; derivation of clean-up standards)



Application of existing methods to terrestrial eco-zones, and the necessity for having new methods applicable to additional eco-zones

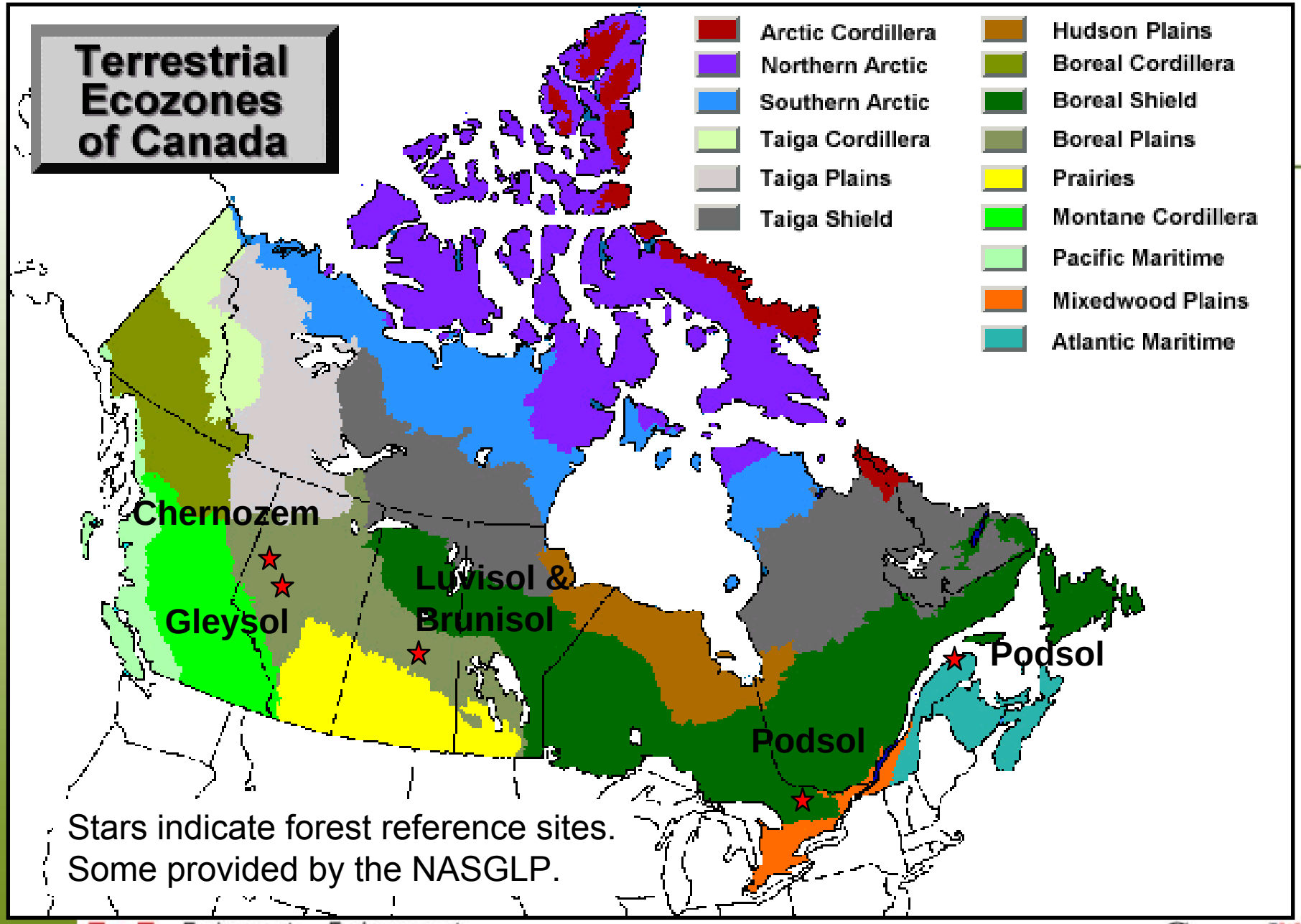
Ecozones adapted from http://www.ccea.org/ecozones/terr.html

Partners in Boreal/Taiga Method Research

- Literature reviews and species recommendations for method development
  - ECT Oekotoxikologie GmbH (J. Römbke, S. Jansch)
  - Saskatchewan Research Council (B. Godwin & M. Moody)
- Ecological and Taxonomic Expertise
  - Royal Roads University (J. Addison)
  - Paragon Consulting (J. Battigelli)
  - Agriculture and Agri-food Canada (V. Behan-Pelletier & J. Clapperton)
- Site Identification and Soil Collection (Reference & Contaminated)
  - Komex Worley-Parsons (M. Brewster, S. Exnor)
  - SHARP Environmental (2000) Ltd. (J. Biegel & M. Maurice)
  - Equilibrium Environmental Inc. (A. Knafla)
  - Husky Energy (C. Meloche)
  - EcoDynamics Consulting Ltd. (J. Nelson & team)
  - Natural Resources Canada (Tri-National Initiative, A. Rencz & R. McNeil)
- Method Development
  - Environment Canada (BMD) – (J. Princz, L. Beaudette & technical staff)
  - Saskatchewan Research Council (M. Moody) – boreal plant tests

Steps for Development of Boreal/Taiga Test Methods

- Establishment of test species from native plant seed sources or invertebrate collection through heat extraction for reference soils
- Sort, identify and culture candidate species
- Establishment of test design, parameter limits and test endpoints
- Performance of tests in a variety of reference soils from across the boreal and taiga eco-zones
  - Development of performance data to help establish validity criteria, and assess applicability of tests to a variety of soils
- Assess the performance of tests using a variety of test system designs
  - Re-layering of soil horizons vs intact soil cores
    - (e.g., 1 to 25 cm depth depending on horizon)
- Performance and applicability of tests in the assessment of contaminated soils (e.g., hydrocarbon, metal and brine contamination)


Terrestrial Ecozones of Canada
Arctic Cordillera
Northern Arctic
Southern Arctic
Taiga Cordillera
Taiga Plains
Taiga Shield
Hudson Plains
Boreal Cordillera
Boreal Shield
Boreal Plains
Prairies
Montane Cordillera
Pacific Maritime
Mixedwood Plains
Atlantic Maritime
Chernozem
Gleysol
Luvisol & Brunisol
Podsol
Podsol
Stars indicate forest reference sites.
Some provided by the NASGLP.

Collaborative Efforts

- How are (bio)geochemical data presently used by your organization?
  - Helps establish of reference soil locations across Canada, 'typical' of various eco-zones
    - Existing knowledge and experience of staff, and preliminary characterization data can help find sites suited to soils and eco-zones to which the methods are applicable
  - Using well-characterized reference soils helps broaden the application of new test methods and assists with the method standardization process

Collaborative Efforts

What can you add to the core tri-national activities?

1. Recommend existing EC reference locations that have been biologically characterized (i.e., surface soil fauna, plant community, terrestrial ecology) for inclusion in the Tri-national Initiative
2. Provide any chemistry derived from testing of the reference locations (i.e., surface and immediate sub-surface soils)
   - e.g., soil horizons collected include: LFH, Ah, Ae, Bt, Bm, Ck
3. Provide any biological test performance data derived from testing of the reference soil locations

Collaborative Efforts

What is the value of the Tri-national soil sampling survey to your research effort?

- Supports our initiative to develop new ecologically-relevant biological test methods
  - Allows for the identification, access, and characterization of a reference site; the collection of new organisms; and generation of test species performance data
  - Helps ensure that the methodologies are applicability to a variety of soils from different eco-zones
  - Streamlines sampling efforts and encourages exchange of information between programs *(e.g., NRCan / EC joint sampling effort for podsol soils north of Pembroke, Ontario)*

Collaborative Efforts

Does the Tri-national Project provide you with opportunities for continued or new joint activities?

– **Absolutely !**

- Contributes to efforts to establish new test methods and species applicable to other Canadian eco-zones
- Establishes permanent reference soil locations for future method development efforts
- Possibility of inclusion of existing EC reference soil locations as part of the Tri-national Initiative [e.g., Saskatchewan (2 sites) and Alberta (2 sites)]