



Environment
Canada

Environnement
Canada

Canada

“Importance of Baseline Environmental Data to Support Biofuels Decision Making in Canada-A Progress Report.



**Biofuels and Bioenergy
A Changing Climate
IEA Bioenergy Symposium
UBC Vancouver B.C.
August 23, 2009.
Terry McIntyre Ph.D.**

Purpose of Presentation

- Outline importance of prior “informed” decision making for assessment of environmental aspects of biofuels
- Introduce results of Environment Canada’s meta-analysis of environmental data for biofuels
- Showcase new biofuels research under way
- Introduce domestic and international biofuel partnerships as new sources of environmental data
- Suggest future research needs and priorities

Canada Biofuel Strategy Drivers

1. Energy Security / Diversity
2. Rural Development / Revitalization
3. Environmental Benefits

Canadian Federal Government Renewable Fuels Strategy

- Government of Canada commitment to expand the production and use of cleaner renewable biofuels such as ethanol and biodiesel via four part strategy announced in 2006 designed to:
 - reduce the greenhouse gas (GHG) emissions resulting from fuel use,
 - expanded production of biofuels,
 - accelerate the commercialization of new biofuel technologies, and
 - provide new market opportunities for agricultural producers and rural communities.



Government of Canada Renewable Fuels Strategy Delivery Platform 2006ff

Increasing the retail availability of renewable fuels

Supporting the expansion of Canadian production of renewable fuels

Accelerating the commercialization of new technologies

Assisting farmers to seize new opportunities in this sector

Regulations

- 5% renewable content based on the gasoline pool by 2010
- 2 % renewable content in diesel and heating oil by 2012, upon successful demonstration of renewable diesel fuel use under the range of Canadian conditions

Lead: Environment Canada

ecoENERGY for Biofuels

\$1.48 billion towards operating incentives to producers of renewable alternatives to gasoline and diesel based on production levels and other factors (over 9 years).

- Up to 10 cents per litre to renewable alternatives to gasoline
- Up to 20 cents per litre to renewable alternatives to diesel
- Incentive rates will be based on average industry profitability
- Funding is "expected" to end March 31, 2017

Lead: Natural Resources

Next-Generation Biofuels Fund

\$500 million for investment with the private sector (over 8 years)

- Managed by Sustainable Development Technology Canada (SDTC)
- Establishing large-demonstration-scale for the production of next-generation renewable biofuels

Canada's leading-edge technologies in the biofuels area make it well positioned to become a world leader in next-generation renewable fuels

- Funding end March 31, 2015

Lead: Natural Resources Canada and Environment Canada

ecoAgriculture Biofuels Capital initiative (ecoABC)

\$200 million initiative to increase renewable fuel capacity (over 4 years)

- Providing repayable contribution towards the capital costs for construction or expansion of transportation biofuels production facilities which have a minimum 5% farmer equity investment.
- Up to \$25 million per project or 25% of eligible project costs, whichever is less
- Payment upon completion of the plant
- 8 to 12 projects expected
- Funding ends March 31, 2011

Lead: Agriculture and Agri-Food Canada

Biofuels Opportunities for Producers Initiative (BOPI)

\$20 million to assist farmers and rural communities hire experts who can:

- Assist in developing business proposals
- Undertake studies necessary to create and expand biofuels production capacity
- Up to \$300,000 per project representing no more than 75% of project costs
- First \$11.6 million funded 84 projects
- Funding ends March 31, 2008



Environment Canada

Environnement Canada



Scientific Approach to Understanding the Environmental Impacts of Biofuels

Understand, inform, and help government(s) minimize environmental effects and maximize sustainability / utility / benefits of biofuels and co-products throughout their entire lifecycle.

Increased land use,
& water use, increased
pesticide use, monoculture
habitat, diversity, novel
wastes, losses, GMO risks.

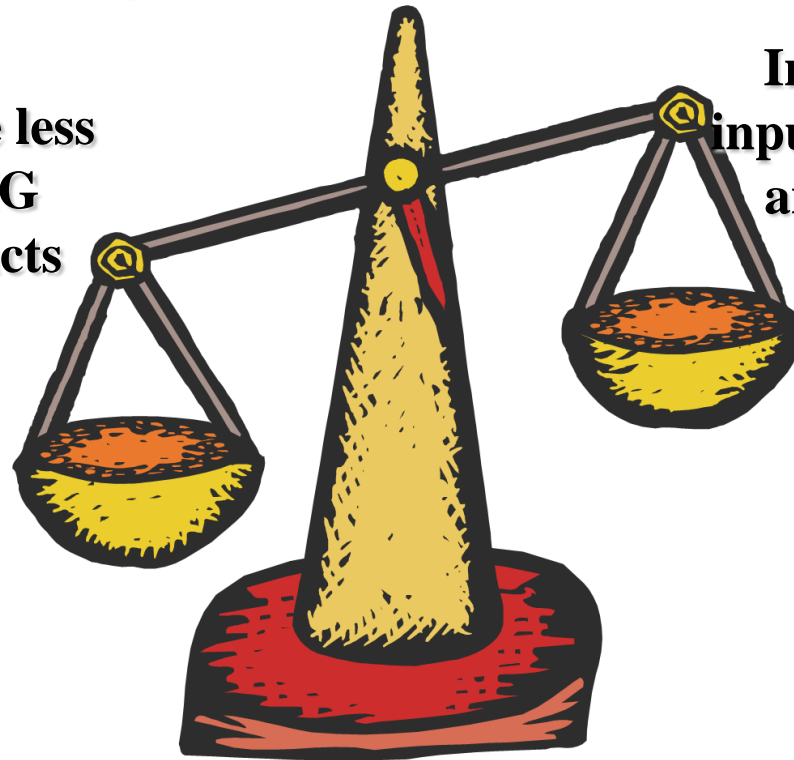


Carbon sequestered, CAC's
and GHG reduced, green
chemistry, air, water quality
improved, reduced waste.

Biofuels are expected to be environmentally friendly, sustainable...

...and should yield net benefits

Bioproducts usually have less embedded energy/ GHG emissions, and bioproducts can be close to climate neutral...

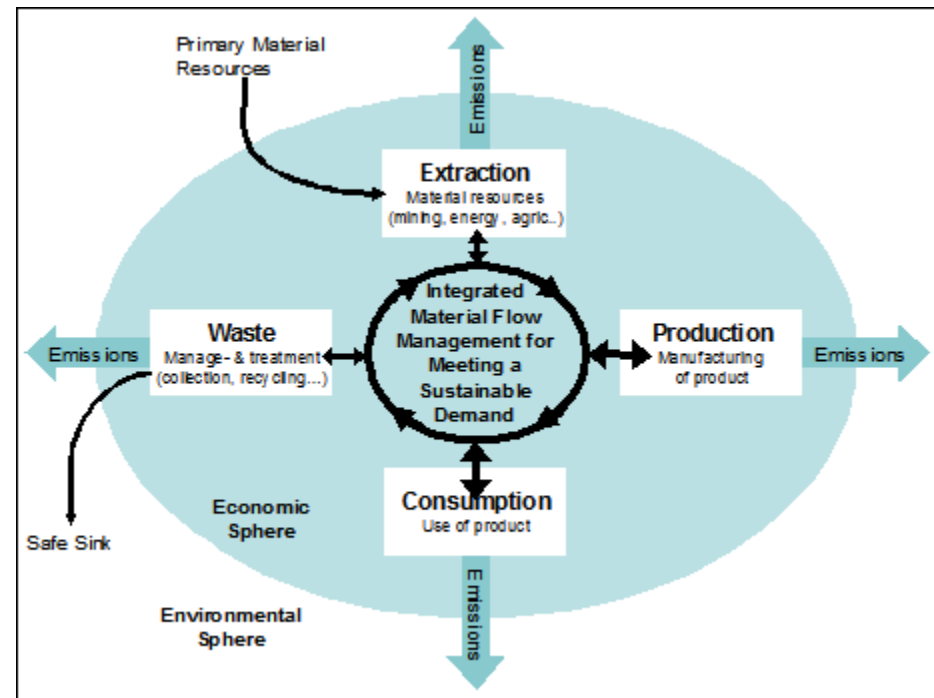


Increased agricultural inputs/ land and water use and different emission profiles

...but the size and type of benefits, depend on prior identification and integrating environmental considerations / data explicitly and up front directly into the process

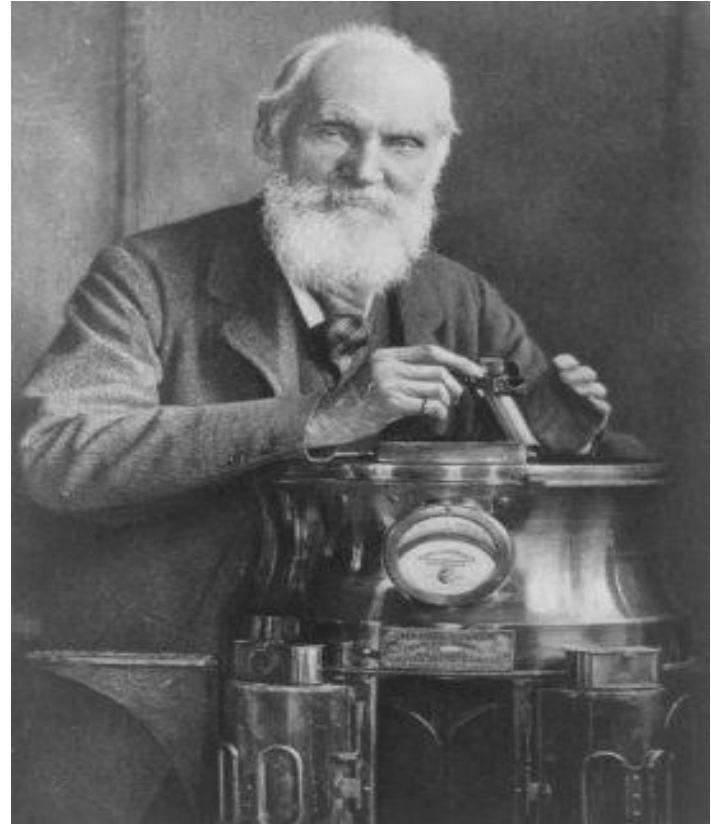
What Environmental Data is Currently Available?

To begin to make informed environmental decisions and by extension good sustainability decisions on all aspects of biofuels , we will urgently need a range of representative baseline environmental data-ideally generated “in front” of the decision making process and under representative Canadian conditions – so as to inform the policy, regulatory, enforcement and scientific process



Importance of Baseline Environmental Data for Biofuels

- *“That which you cannot measure you cannot manage...that which you cannot measure you cannot improve.*



Life Cycle “Meta” Analyses (LCA)

(Curran 2006) (Dale 2006) Miller (2007) (Larson (2008) (UKERC 2008), (OECD 2008)

	Agriculture Feedstocks				Waste Feedstocks		
Candidate Env. Assessment Parameters	<i>Kaltschmitt 1997 Sugar Beet Wheat Potato</i>	<i>Puppan 2001 Sugar Beet Winter Wheat Potato</i>	<i>Reinhardt 2002 Sugar Beet Wheat Potato</i>	<i>Hu 2004 Cassava</i>	<i>Kadam 2004 Corn Stover</i>	<i>Sheehan 2004 Corn Stover</i>	<i>Tan & Culuba 2002 Agricultural Cellulosic waste</i>
	Germany	Germany	Europe	China	India	USA	Philippines
Resource Depletion	↑	↑	↑	↑	↑	↑	↑
All GHG Gases	↓	↓	↓	NA	↓	↓	↓
Biodiversity	NA	NA	NA	NA	NA	NA	NA
Acidification	—	—	↑	NA	↓	↑	↑
SO_x	↑	NA	↑	NA	NA	NA	NA
NO_x	↓	NA	↑	↑	NA	NA	NA
Eutrophication	NA	NA	↑	NA	↓	NA	↑
Human Toxicity	NA	—	NA	NA	↓	NA	↑
CO	NA	NA	↑	↓	NA	NA	NA

Page 10 – August-28-09



Environment
Canada

Environnement
Canada

NA – Not Assessed

— No significant change

↑ – Increased impact for bio-ethanol

↓ – Decreased impact for bio-ethanol

, Curran 2006, Blottnitz, 2006, Dale 2006 McIntyre 2006, Landis 2007

Canada

Life Cycle Analysis (LCA)

(Curran 2006) (Dale 2006) Miller (2007) (Larson (2008) (UKERC 2008), (OECD 2008)

	Agriculture Feedstocks				Waste Feedstocks		
	<i>Kaltschmitt 1997 Sugar Beet Wheat Potato</i>	<i>Puppan 2001 Sugar Beet Winter Wheat Potato</i>	<i>Reinhardt 2002 Sugar Beet Wheat Potato</i>	<i>Hu 2004 Cassava</i>	<i>Kadam 2004 Corn Stover</i>	<i>Sheehan 2004 Corn Stover</i>	<i>Tan & Culuba 2002 Agricultural Cellulosic waste</i>
	Germany	Germany	Europe	China	India	USA	Philippines
<i>PM</i>	NA	NA	-	-	NA	NA	NA
<i>Ecological Toxicity</i>	NA	—	NA	NA	NA	NA	NA
<i>Photochemic al Smog</i>	NA	NA	-	NA	NA	-	-
<i>HC</i>	NA	NA	-	-	NA	NA	NA
<i>Solid Waste</i>	NA	NA	NA	NA	-	NA	NA
<i>Land Use</i>	NA	NA	NA	NA	NA	—	NA
<i>Water Use</i>	NA	NA	NA	NA	—	NA	NA
<i>Ozone Depletion</i>	-	-	NA	NA	NA	-	NA
<i>Odour</i>	NA	NA	NA	NA	-	NA	NA



What do the Life Cycle Analyses tell EC?

- Scientific evidence base to support environmental claims of biofuels is weak.
- Many important environmental parameters not routinely measured.
- The environmental data is not very robust nor yet representative of Canadian conditions.
 - Studies are relatively narrow engineering analyses that assume one set of activities replaces another.
 - Most are solely GHG reduction or energy balance studies often neglecting other important areas entirely (e.g., aqueous emissions, clean air contaminants, ecosystem quality, sustainability, biodiversity, nutrient cycles, landscape effects, material flows, socio economic impacts and human health considerations).
 - Few were conducted or are representative of Canadian climatic conditions, biodiversity, geographic and threshold levels
 - Much is funded and/or published by proponents of the products and/or technologies.
 - Most data consists of estimates provided by models or emission factors and may or may not accurately reflect actual benefits to be achieved.
 - The data (and responsibility) is spread over multiple departments and groups across North America, South America, and Europe
 - LCA's coming under criticism for the use of quantitative data only.
- The issue is complex and very technical and lends itself to limited understanding of theoretical vs. likely/achievable benefits.
- Benefits of one type may be offset by negative impacts in other areas as highlighted in the scan of published Life Cycle studies on biofuels.

Environmental Evidence and “Weight of Evidence” from Global Evaluation of Life Cycle Analysis (LCA) of Biofuels

- Selected and “punctuated meta-analysis” of the global LCA literature on biofuels to determine potential environmental “burdens and benefits” specifically related to:
 1. Biomass feedstock selection and harvesting.
 2. Biomass conversion to biofuels and other co-products.
 3. Blending, transportation, storage, and distribution of biofuels.
 4. Tail pipe emissions from combustion of blended biofuels.
 5. Spills of biofuels and fate in ambient environment.

“LCA is a systematic set of procedures for compiling and examining the inputs and outputs of materials and energy and the associated environmental impacts directly attributable to the functioning of a product or service system throughout its life cycle” (ISO 14040.2).

1) Biomass Feedstock Selection and Harvesting:

This area will likely have the biggest impact on the environment

- Need to better identify “landscape effects” from accelerated and increased biomass production.
- This aspect is likely to have the largest impact on the environmental and agronomic “benefits and burdens”.
 - *Sustainable farming practices will be key.*
 - *High intensity monoculture creates challenges.*
 - *Soil quality, nutrient loading, habitat and biodiversity, energy intensity.*
- Collaboration with Agriculture and AgriFood Canada, NRCan and DFO, landscape ecologists, biodiversity specialists and the Canadian Forestry Service is key to leveraging Canada’s strengths.

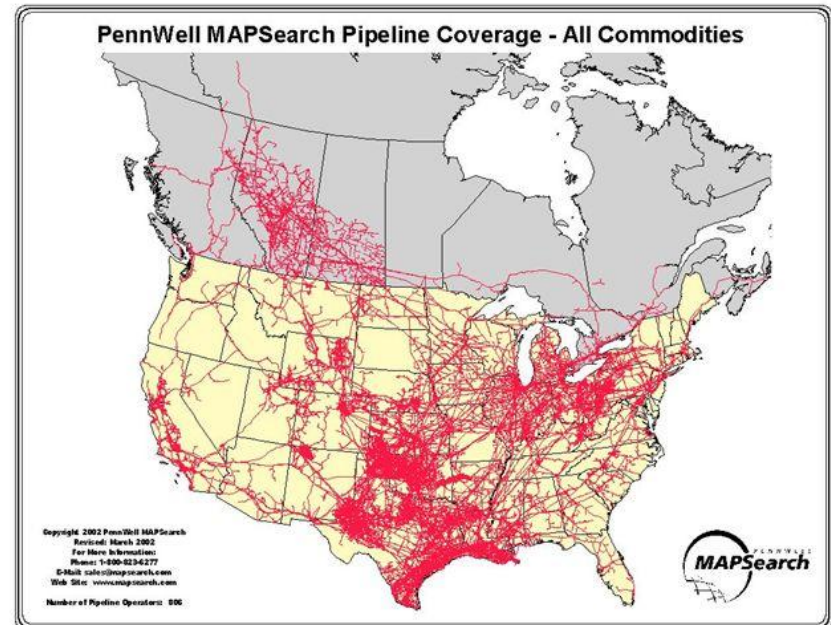
2) Biomass Conversion to Biofuels and Other Co-products: Biofuel facilities are biorefineries with a variety of inputs, co-products, and emission streams

- EC studies completed on corn/wheat ethanol, and biodiesel production facilities indicate absence of baseline environmental data throughout:
 - *Ethanol*
 - *water use concerns (BOD, COD, consumption).*
 - *VOC emissions (both controlled and fugitive)*
 - *Huge CO2 emissions and co-products.*
 - *Biodiesel*
 - *Hexane and methanol emissions.*
 - *water usage/discharges for biodiesel technologies unknown*
 - *Other area's of concern.*
 - *Energy intensity (fossil fuel use and GHG emissions), Particulate matter (PM) emissions, GMO (bacteria, enzymes, yeasts, biomass) fate.*
 - *Ecological footprint will vary considerably depending upon design, size, location, and type of production facility and feedstock utilized.*



3) Blending, Transportation, Storage, and Distribution of Biofuels: Likely to be controversial

- Limited government attention given to environmental impacts / changes to “infrastructure” necessary to support implementation of RFS.
- Incomplete information (costs, regional inequities, incompatibilities) relating to biofuels integration into existing petro-chemical infrastructure
- EC / TC studies completed on impacts of biodiesel and ethanol by EC
 - *Ethanol*
 - Greater transportation impacts (GHGs, PM, tailpipe emissions, etc) due to truck and rail requirement (vs pipeline for petroleum diesel).
 - Increased risk of major spill due to truck/rail transportation modes.
 - Economic costs for compliance and “legacy vehicles”.
 - *Biodiesel (similar issues to ethanol).*



4) Tail Pipe Emissions from Combustion of Blended Biofuels

- General observations from recent EC Ethanol Blended Gasoline research projects:
 - *Some emissions go up some emissions go down.*
 - *For example the NOx went up in low blends and down in high blends.*
- General observations from recent EC Biodiesel research projects:
 - *Most emissions go down on modern engines with emission controls.*
 - *In general, particulate matter, carbon monoxide, and hydrocarbon emissions are generally lowered with the use of biodiesel.*
 - *NOx emissions do not appear to be affected.*
 - *Modern emission controls are “clean” and erode much of the blended biofuel benefits*
- Research is on-going to look at impacts in other important vehicle and engine sectors such as recreational vehicles, construction equipment, and small utility engines.

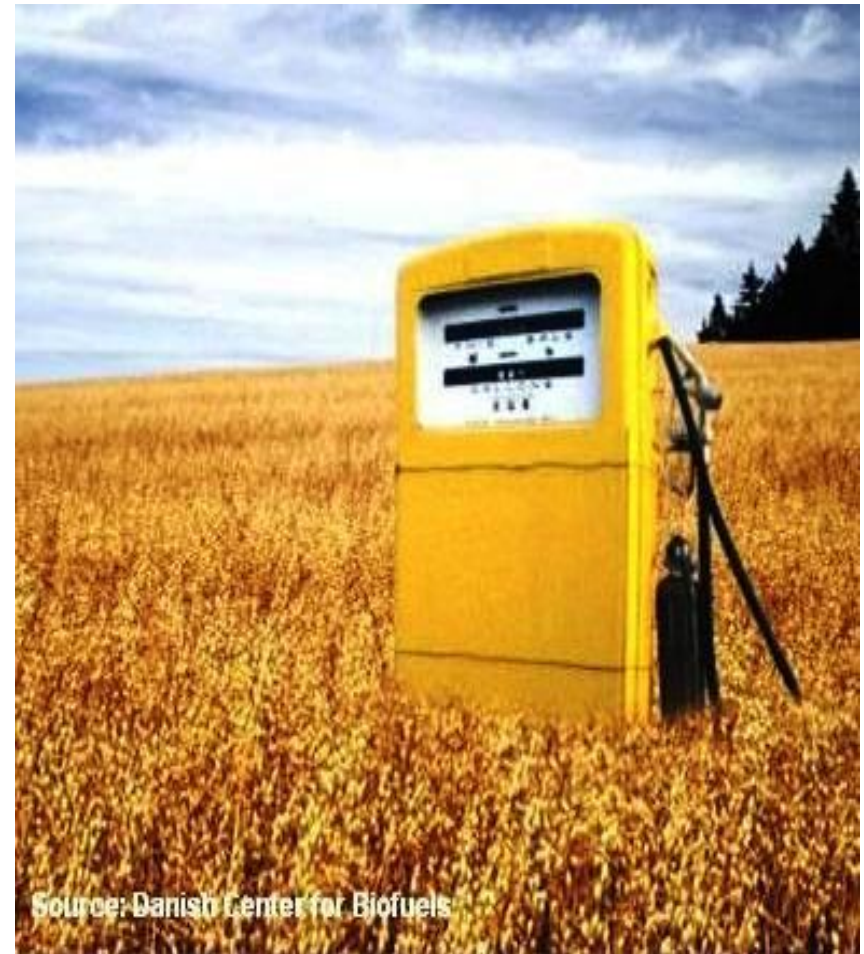


5) Spills of Biofuels and “Fate” in Ambient Environment:

- Biofuel blends may make clean up more complex
- Spills of biofuels and blended fuels are inevitable as more are introduced into commerce.
- Limited EC research to date shows:
 - *High variability in biofuel fuel composition, especially for biodiesels.*
 - *Some biofuels and blends have significant toxicities and water solubility.*
- Currently significant knowledge gaps exist in behaviour of biofuels and appropriate remediation options:
 - *What happens to biofuels after a spill (particularly in aquatic and marine environments?)*
 - *How toxic are biofuel spills?*
 - *Best-practices for clean-up?*
 - *Interim EC advice to “first line” defenders*

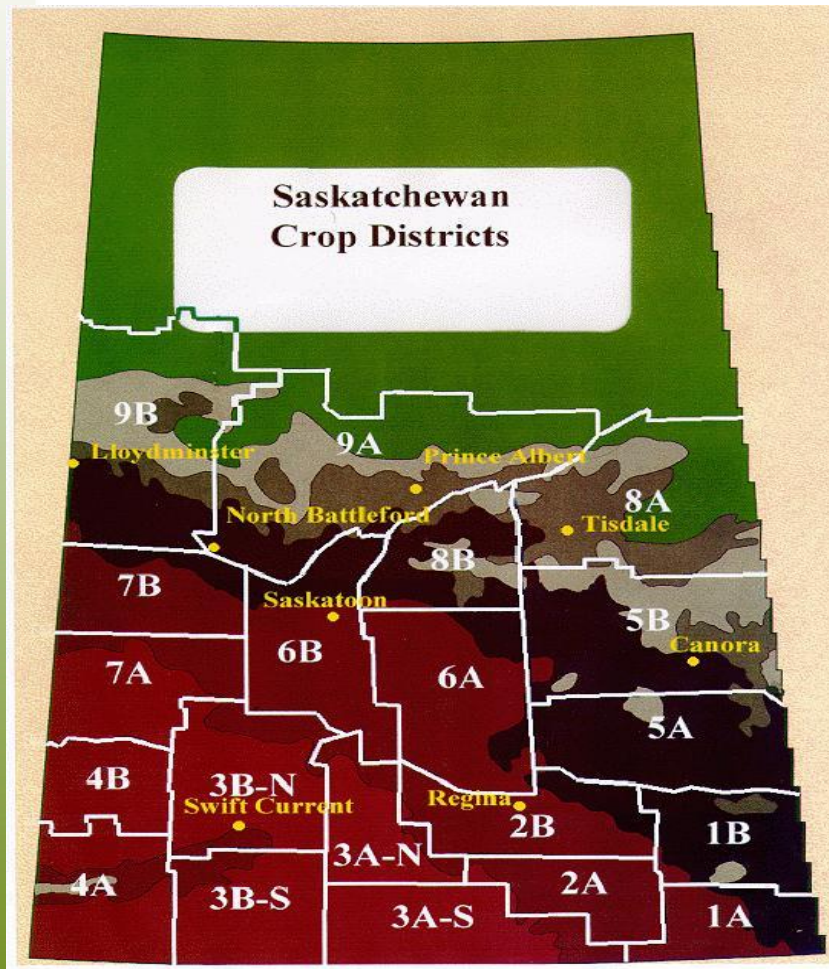


“Re-Vitalized” EC Efforts at Creating Conditions for Accelerated Environmental Knowledge Acquisition on Biofuels



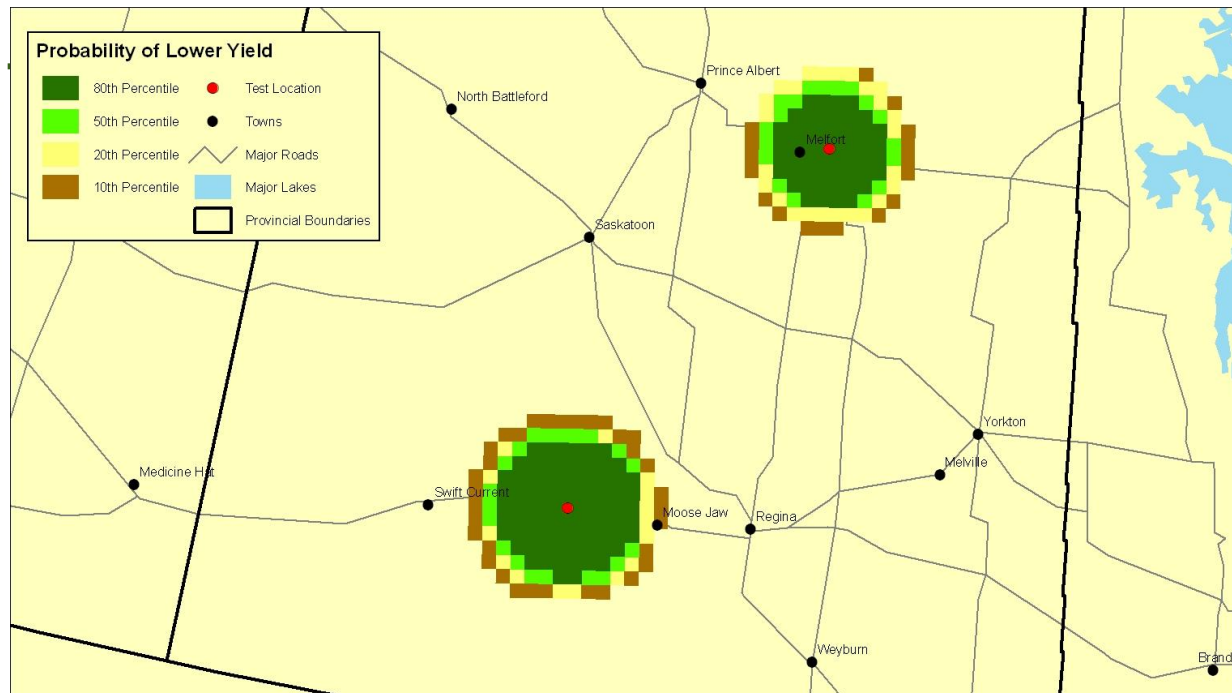
“3rd Generation” Science Activities Underway

AAFC Biomass Inventory Mapping Assessment Tool Project



- Working with AAFC, combination of EC / NRCan / Transport Canada / Ducks Unlimited / Canadian Petroleum Producers “data-sets” for BIMAT model to determine “threshold levels” for sustainable harvesting of crop whole plant biomass.
- Important research “platform” for determination of sustainability, and productivity for biofuels and biorefinery production facilities across Canada. (at the ecozone level utilizing Prairie Provinces as a “microcosm”.

BIMAT Analysis Process

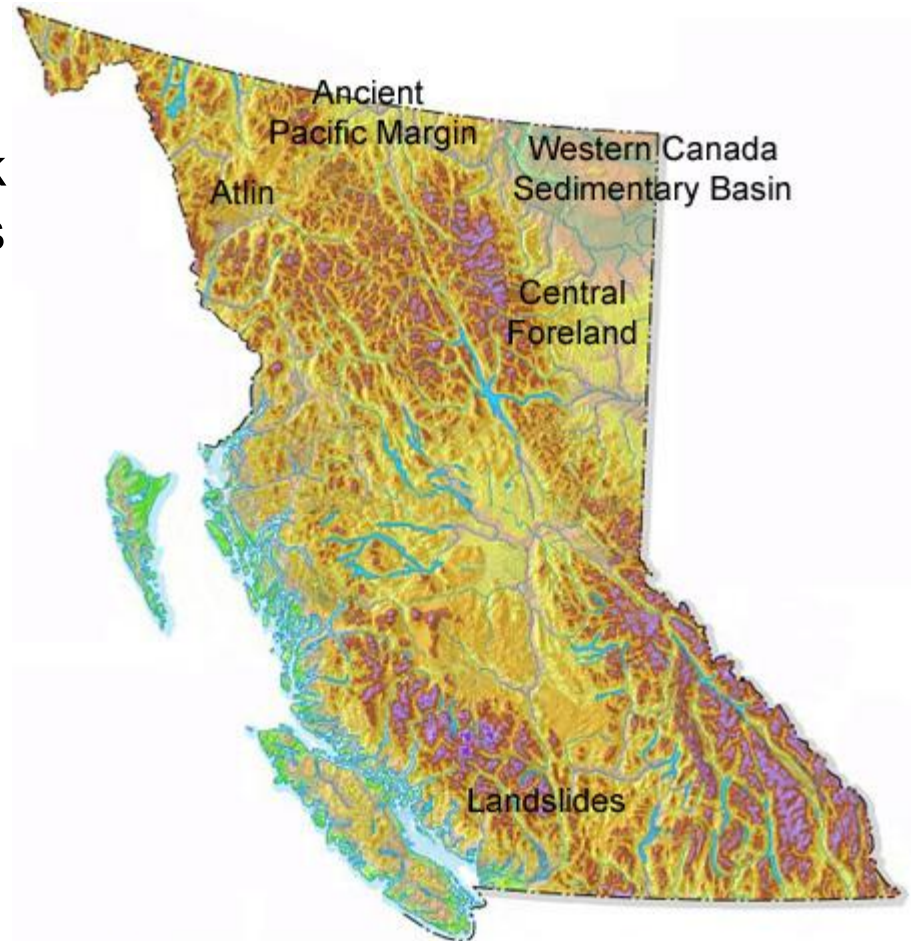


- User has choice of background map
- Contextual data will be selectable (availability scale dependent)
- User will choose a point
- Two choices of query – radius or quantity based

- User will select type of material, amount or radius.
- For herbaceous, user will have choices about tillage system, cattle use and harvest frequency
- When all options have been selected, user can run analysis and the area on the map will be displayed and a report produced. The user can choose to save the report as a PDF and can also download a GIS file with the outline of the area selected in the query.
- User can then repeat with another point or the same point and different options.

Use of BC as a “Microcosm” for Determination of Effects from Large Scale Removal of Forestry “Pine Beetle Killed” Biomass

- Project with AAFC / CFS / BC Forestry and Energy / UBC and NSERC Bioconversion Network to examine sustainability issues and landscape effects from removal of diseased MPB timber in BC and Prairie Provinces
- Opportunity to utilize this project for comparable biomass removal of forestry “wastes” from Quebec and Atlantic Provinces



Use of Marginally Contaminated Lands for Biomass Production?

- USEPA has identified and mapped Brownfield sites amenable to biomass production in all 50 states and estimates a 150,000 ton biomass potential. Latin American initiative also under way
- Many sites currently served by utilities, transportation and water.
- Concerns over both current GHG emissions from remediation activities as well as potential for producing biomass on site to offset emissions and capture inherent energy content
- EC to contract out “feasibility” study to explore Canadian approach



EC – AAFC - NRCan Research Project under AAFC “SAGE” Program.



- Augmenting EC -AAFC – CFS BIMAT model with meteorological, wildlife, biodiversity, and water data from EC; and GHG, fertilizer, pesticide and biosolids data from AAFC to better understand and reduce landscape effects, assist in optimal plant selection, cropping, and harvesting for next generation of “bioenergy” plants
- Ultimately, assist in development of determinants to allow for optimization of environmental performance of plants.



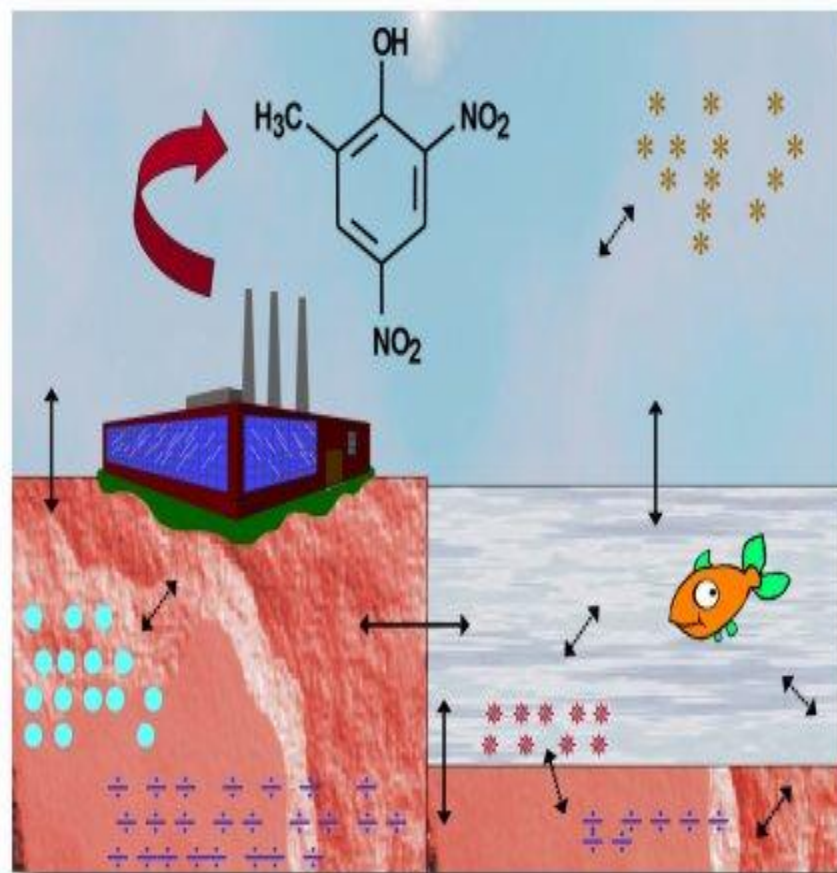
Optimizing the Environmental Performance of Biofuel Production Facilities in Canada (2009-2012)

- Build upon previous environment footprint work
- Sections of Report
 - Section 1: Executive Summary
 - Section 2: Introduction
 - Section 3: Site Selection Consideration
 - Section 4: Ethanol Production Process
 - Section 5: Air Emissions
 - Section 6: Water Uses and Aquatic Environment
 - Section 7: Waste Management
 - Section 8: Health and Safety
 - Section 9: Economic and Social
 - Section 10: Life Cycle Stages
 - Section 11: Gaps, Issues and Path Forward
 - Section 12: References
 - Appendix: Summary of Assessment Criteria, Indicators



New EC Biofuels Ecotox Research

- Designed to better understand biofuels and co-products fate and behaviour when introduced into groundwater, aquatic and marine environments
- Emergency preparedness and contingency planning techniques



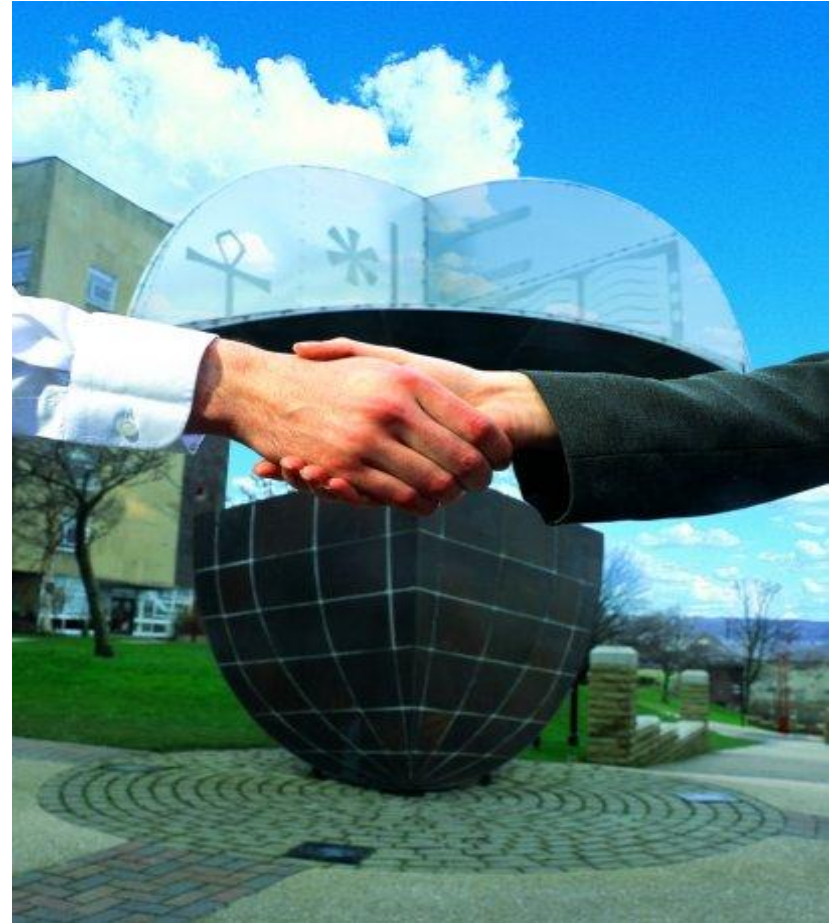
LCA of Bioproducts and Processes Important But....

- One piece of the federal government puzzle of assessment obligation(s) **only and not interchangeable**
- Also need to simultaneously look at “new” environmental challenges for environmental impact, toxicity, environmental performance and LCA analysis
- Need to explore complementary “assessment” research at the domestic and international levels
- New research obligations involves and invites new research partnerships

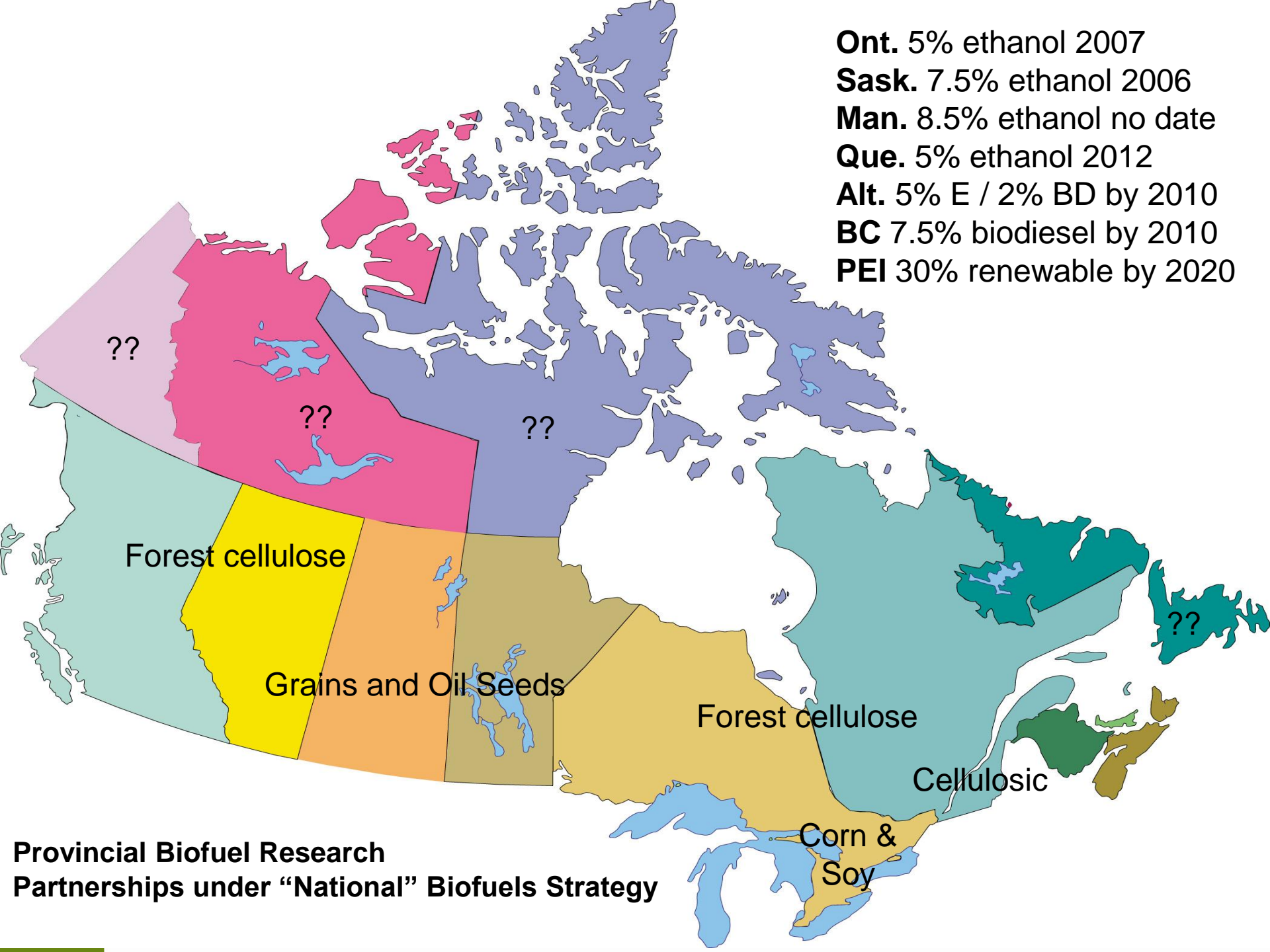


Importance of “Biofuels Research Partnerships” to Environment Canada

- Currently engaged with 55 Canadian universities, five federal departments, 10 provinces, Canadian Petroleum Products Institute and Canadian Renewables Fuel Association, two US departments, 32 US states and indirectly with 190 countries under International Panel on Climate Change.
- Allows for tremendous leverage, information flow, and collaborative research in areas of complementary biofuels research interests.



Ont. 5% ethanol 2007
Sask. 7.5% ethanol 2006
Man. 8.5% ethanol no date
Que. 5% ethanol 2012
Alt. 5% E / 2% BD by 2010
BC 7.5% biodiesel by 2010
PEI 30% renewable by 2020



Provincial Biofuel Research Partnerships under "National" Biofuels Strategy

Relevant Canada / US Activities Underway

Environment Canada / Interstate Technology Regulatory Cooperation /
Canadian Energy Ministers Biofuels Science Bilaterals

- EC-S&T a founding member of Canadian Energy Ministers Biofuels working group and US “equivalent” ITRC state, industry, NGO working groups on biofuels sustainability, landscape effects, low carbon fuel standards, ecotoxicity, and spills research.



Environment
Canada

Environnement
Canada



Environment
Canada

Environnement
Canada

Relevant Science Activities Underway

Environment Canada / USEPA / USDOE Biomass to Biofuels Collaboration

- USEPA has approached Environment Canada to compare notes on progress, direction, research priorities, and possible future research collaboration for science underpinning respective RFS strategies.
- Science summit proposed for Spring 2010 at Environmental S&T Centre labs in Ottawa.
- Environment Canada Minister working with USDOE Director on Clean Energy Dialogue
- EC / USDOE collaboration occurring at IEA Workshop.



**Environment
Canada**

**Environnement
Canada**

IPCC Special Study on Renewable Energy (SSREN) for Copenhagen 2010

- New global initiative launched to examine role and contributions of renewable energy to climate change, GHG reduction and amelioration, energy substitution, and environmental impacts
- Will provide an excellent source of baseline information to Can / EU and global renewable energy community in the conduct of performance measurement and determination of climate change compatibility with evolving renewable energy technologies
- EC provides “lead” Canadian author to IPCC 190 country Scientific Study on Renewable Energy (SSREN)
- Study will examine CC, GHG implications, environmental impacts, and energy potential of all renewable energies by 2010

IPCC

INTERGOVERNMENTAL
PANEL ON
CLIMATE CHANGE



International Energy Agency

- The International Energy Agency (IEA) is an intergovernmental organisation which acts as energy policy advisor to [28 member countries](#)
- Its mandate has broadened to incorporate the “Three E’s” of balanced energy policy making: energy security, economic development and environmental protection.
- Current work focuses on climate change policies, market reform, energy technology collaboration and outreach to the rest of the world, especially major consumers and producers of energy like China, India, Russia and the OPEC countries.
- Canada proud to be an active member on several Task forces



International Energy Agency-Canadian Engagement

- Task 29 : Socio-Economic Drivers in Implementing Bioenergy Projects
- Task 30 : Short Rotation Crops for Bioenergy Systems
- Task 38 : Greenhouse Gas Balances of Biomass and Bioenergy Systems
- Task 39 : Commercialising 1st and 2nd Generation Liquid Biofuels from Biomass
- Task 40 : Sustainable International Bioenergy Trade - Securing Supply and Demand
- Task 41 : Bioenergy Systems Analysis
- Task 42 : Biorefineries: Co-production of Fuels, Chemicals, Power and Materials from Biomass



Candidate Research Agenda

- Mechanisms for improving environmental performance and conversion efficiencies for first generation biofuel production facilities
- Mechanisms for determination of “cumulative” environmental impacts from multiple biofuel facilities
- Spills data, emergency preparedness and contingency planning methodologies(sp. biodiesel in aquatic and marine environments)
- Fate and alternative uses for co-products (sp CO₂, animal proteins, and glycerine)
- Biosafety data (sp. second generation biofuel production and conversion facilities)

Candidate Research Agenda

- Baseline environmental data and standardized approaches / criteria / frameworks for the conduct of life-cycle assessments, environmental impact assessments, sustainability, toxicity, and environmental performance
- Requirements for specific environmental data on air emissions, landscape effects, impacts on biodiversity, water quality and consumption, GHG reductions
- Infrastructure data and environmental consequences from changes required to accommodate large scale blending, storage, transportation, and distribution of biofuels under cold climate conditions
- Improved mechanisms to recover and retain plant nutrients (N,P,K) utilized in plant biomass development



Questions / Comments?

***Terry McIntyre Ph.D. P. Ag.
Senior Science Advisor-Biofuels
Science and Technology Branch
Environment Canada
11th Floor Fontaine Building
200 Sacre-Coeur Blvd.,
Gatineau, Quebec, CANADA
terry.mcintyre@ec.gc.ca***