



NATURAL RESOURCES CANADA - INVENTIVE BY NATURE

Cumulative Human Impacts and Forestry: Where do we begin?

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ARIAL VIEW OF COWICHAN LAKE, MAY 2006 (PHOTO COURTESY OF DON FERN ©)



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Summary of activities at CFS relevant to Cumulative Impacts in forestry

- Vulnerability assessments / evaluation of adaptive capacity
- Forest Change – tracking system, toolkit, integrated assessment
- Adaptive forest management practices (Assisted migration, Genetic variability/adaptation & epigenetics, Innovative nursery practices)



Summary of relevant activities at CFS

- Climate: High resolution climate and CC models and maps
- Climate: Response to CC-related increase of spruce budworm (SBW)
- Interactions
 - MPB/fire/CC
 - drought/forest health/CC
 - growth/mortality

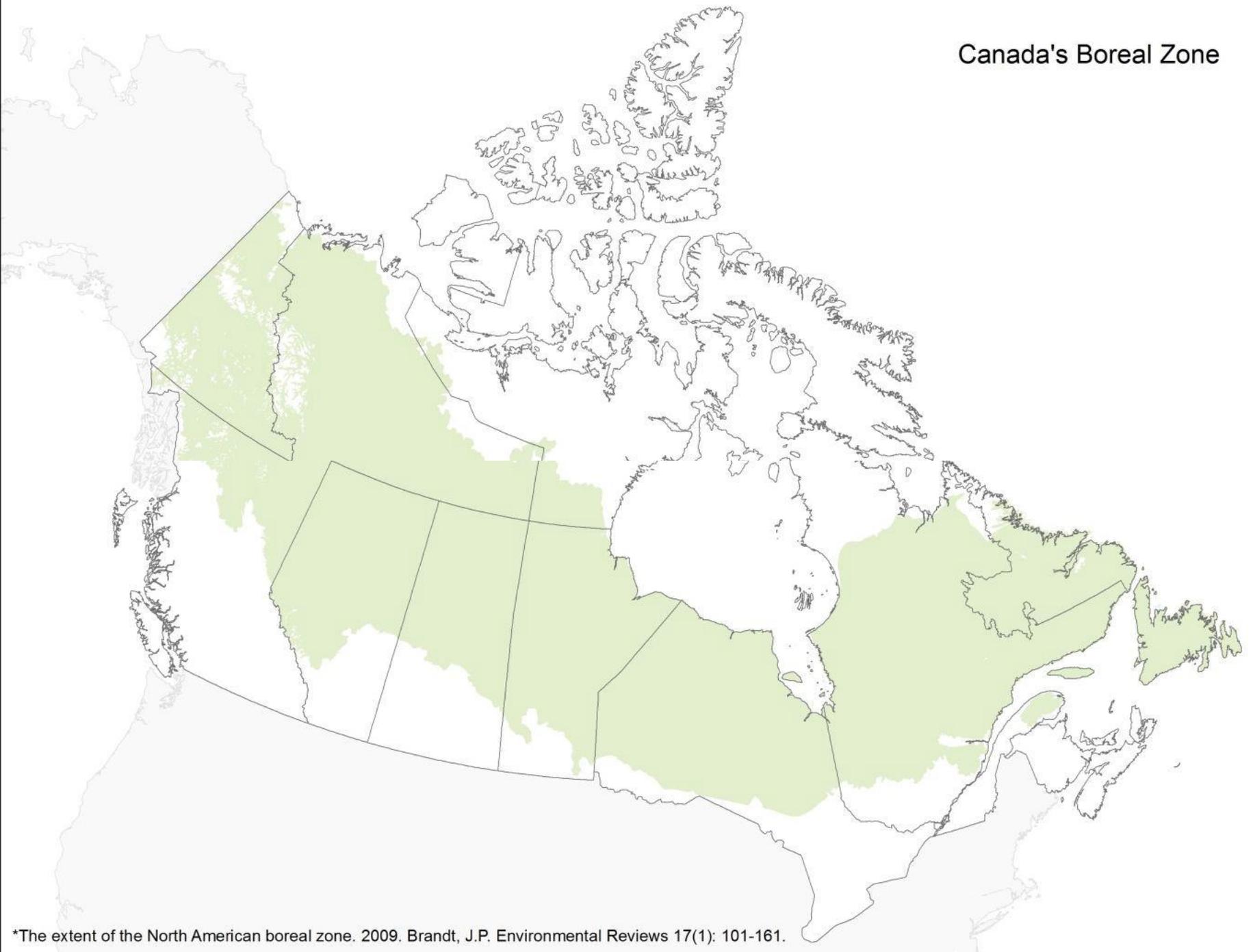


Summary of relevant activities at CFS

- Dendrochronology and future forest projections
- Future ecosystem and climate modeling
- Impacts of CC on boreal transect function
- National transect network for tracking, reporting, forecasting change
- **Cumulative anthropogenic impacts in the boreal forest.**



Canada's Boreal Zone



*The extent of the North American boreal zone. 2009. Brandt, J.P. Environmental Reviews 17(1): 101-161.

Literature Review

Introduction

Summary Tables

Important gaps

a	b	c	d	e
f	1	h	3	j
k	l	2	m	n
o	p	q	r	s
t	u	v	w	x

Key conclusions

a	b	c	d	e
f	1	h	3	j
k	l	2	m	n
o	p	q	r	s
t	u	v	w	x

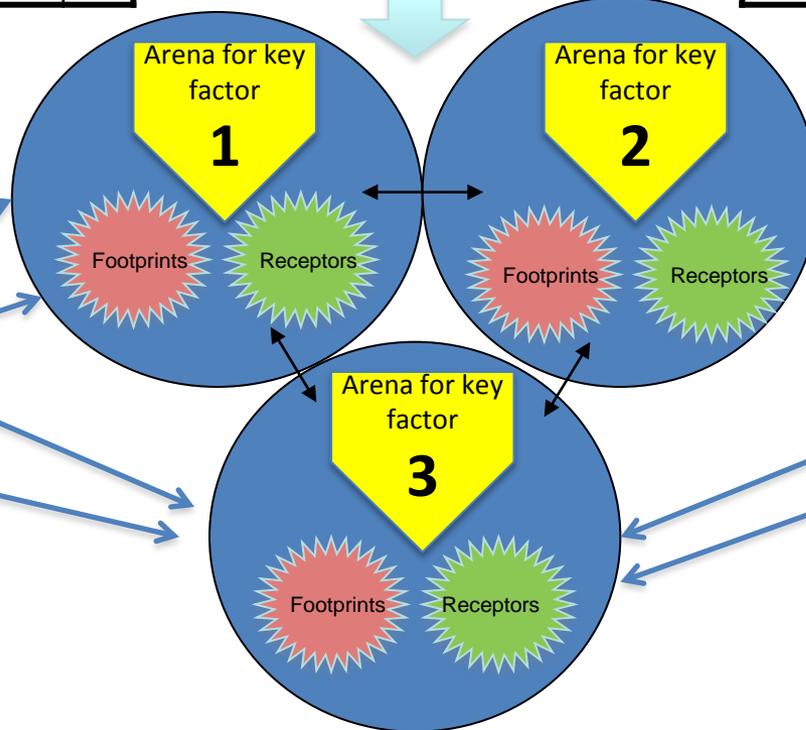
Key factors

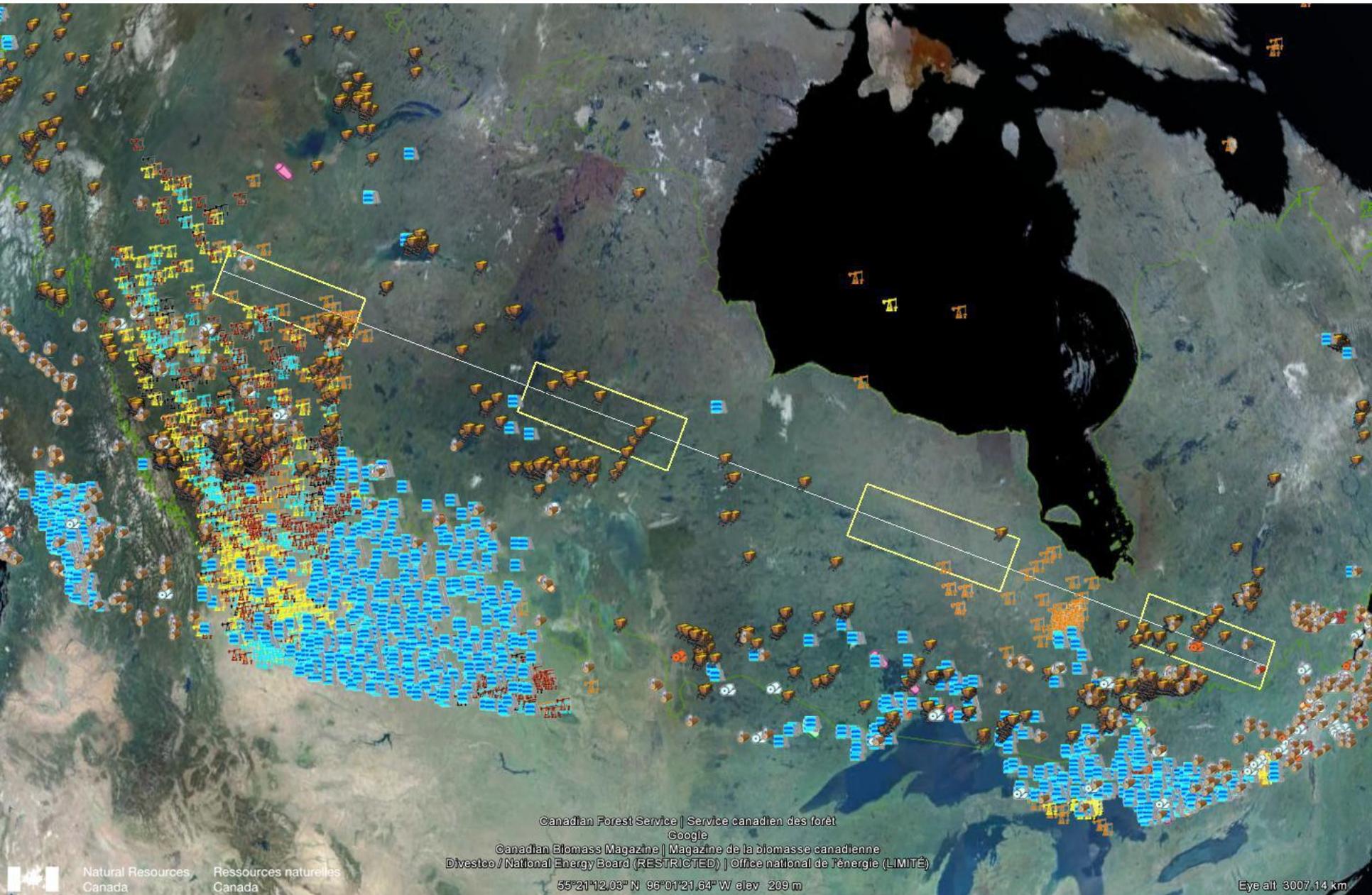
Process & resiliency experts

Landscape experts

Landscape experts

Process & resiliency experts





Canadian Forest Service | Service canadien des forêts
Google

Canadian Biomass Magazine | Magazine de la biomasse canadienne
Divestco / National Energy Board (RESTRICTED) | Office national de l'énergie (LIMITÉ)

55°21'12.03" N 96°01'21.64" W elev 209 m

Eye alt 3007.14 km

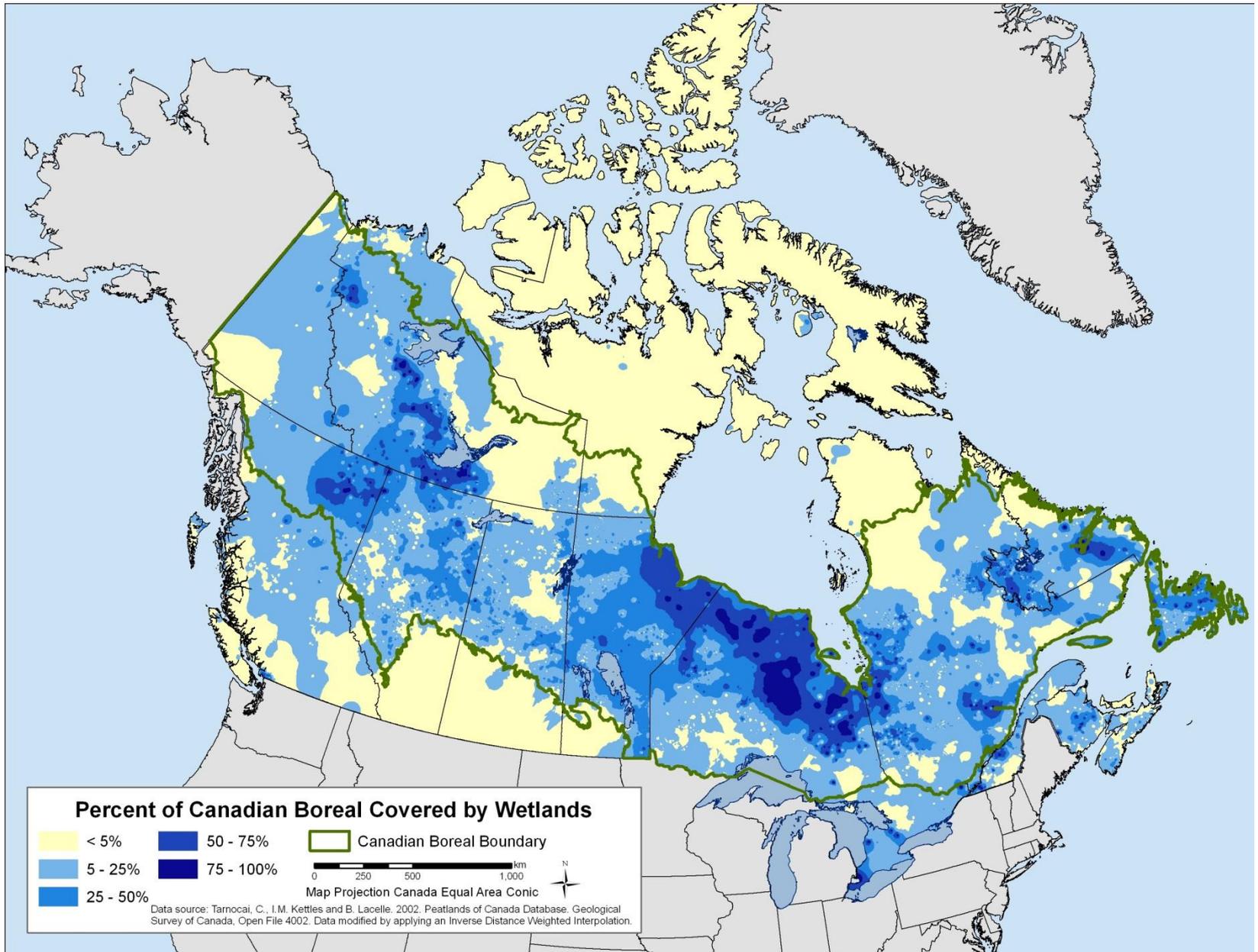
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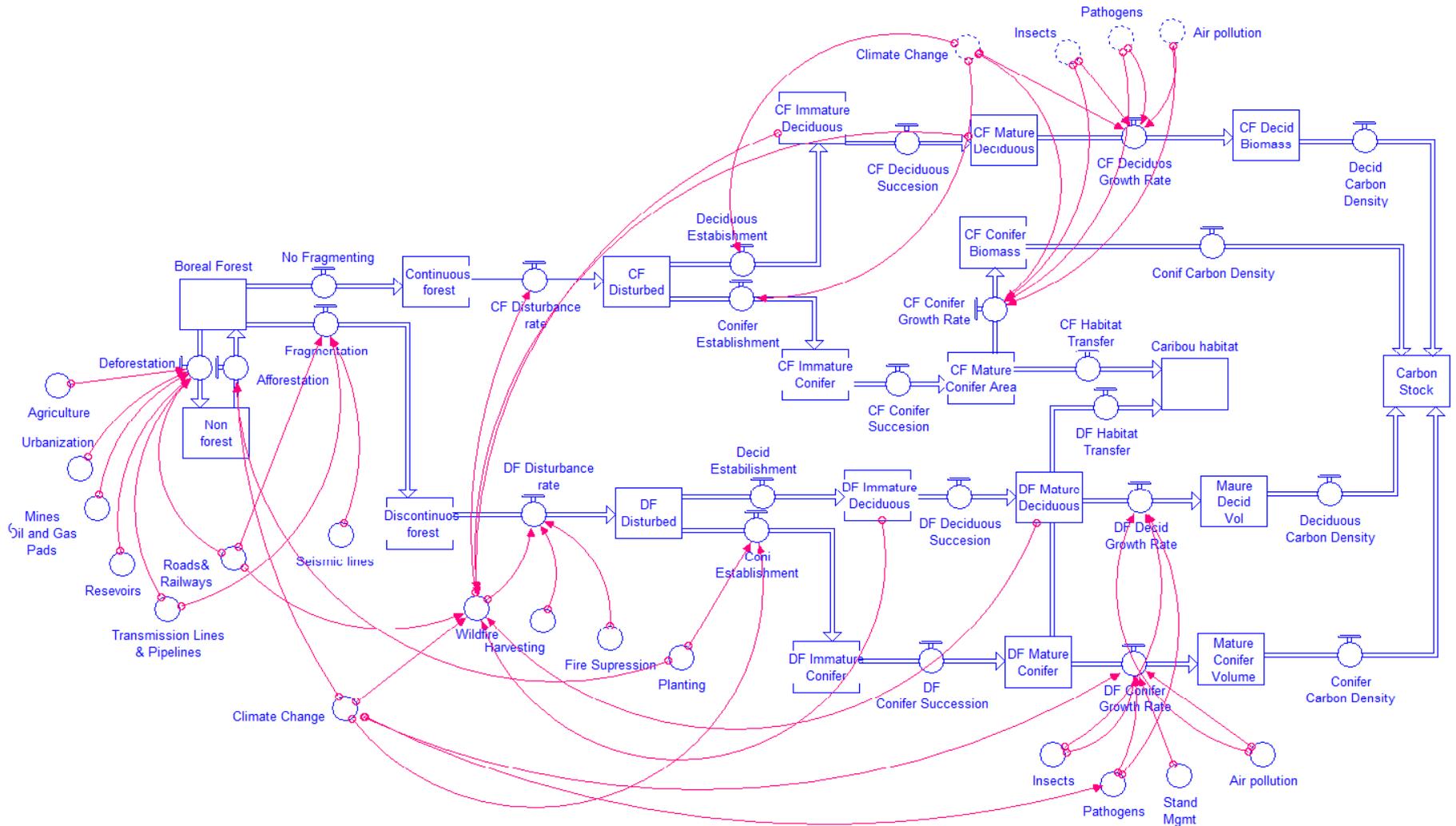
Rating Matrices for Anthropogenic Factors Affecting the Canadian Boreal Forest																								
Indicate a score of 1-10																								
Factor	Extent of Spatial Footprint			Scope of interaction with other factors & processes			Intensity of physical (biological, environmental) impact			Degree of Social impact			Degree of primary interaction with other Factors & Processes			Longevity or persistence of impact			Dearth of ammelioration effort or method for impact			Dearth of knowledge about impact		
	Past	Present	Future	Past	Present	Future	Past	Present	Future	Past	Present	Future	Past	Present	Future	Years	Decades	Centuries	Past	Present	Future	Past	Present	Future
Land use (extant and modified)																								
-Mineral resources																								
Mining																								
Exploration																								
-Energy resources (including production sites, rights-of-way)																								
Oil																								
Gas																								
Hydroelectric																								
-Transportation																								
Roads																								
Railways																								
-Settlement																								
Urban/suburban																								
Rural																								
-Agriculture																								
-Forestry																								
Timber harvest																								
Silviculture/planting																								
-Non-timber forest use																								
Hunting																								
Fishing																								
Tourism																								
Other forest products																								
-Peat mining																								
-Forest/landscape fragmentation (all causes)																								
Extant and Short-term* Climate Change																								
-Acute Disturbances:																								
Fire																								
Pests (Insect & disease outbreaks)																								
Drought																								
-Fundamental shifts or change:																								
Climate zones																								
Biodiversity & natural migrations																								
Pest (insect, disease, vegetation) dynamics																								
Productivity/maladaptation																								
Permafrost degradation																								
Fire adaptation/maladaptation (serotiny)																								
Modified Hydrological Systems																								
Impoundments (size, number, configuration)																								
Flowpath intersection/alteration																								
Placer mines																								
Aquatic/Riparian																								
Biodiversity																								
Invasive Introductions																								
Terrestrial (soils/belowground)																								
Terrestrial (aboveground)																								
Aquatic/Riparian																								
Pollution																								
Air																								
Water																								
Soil																								
Modified Fire Dynamics																								
Fire suppression																								

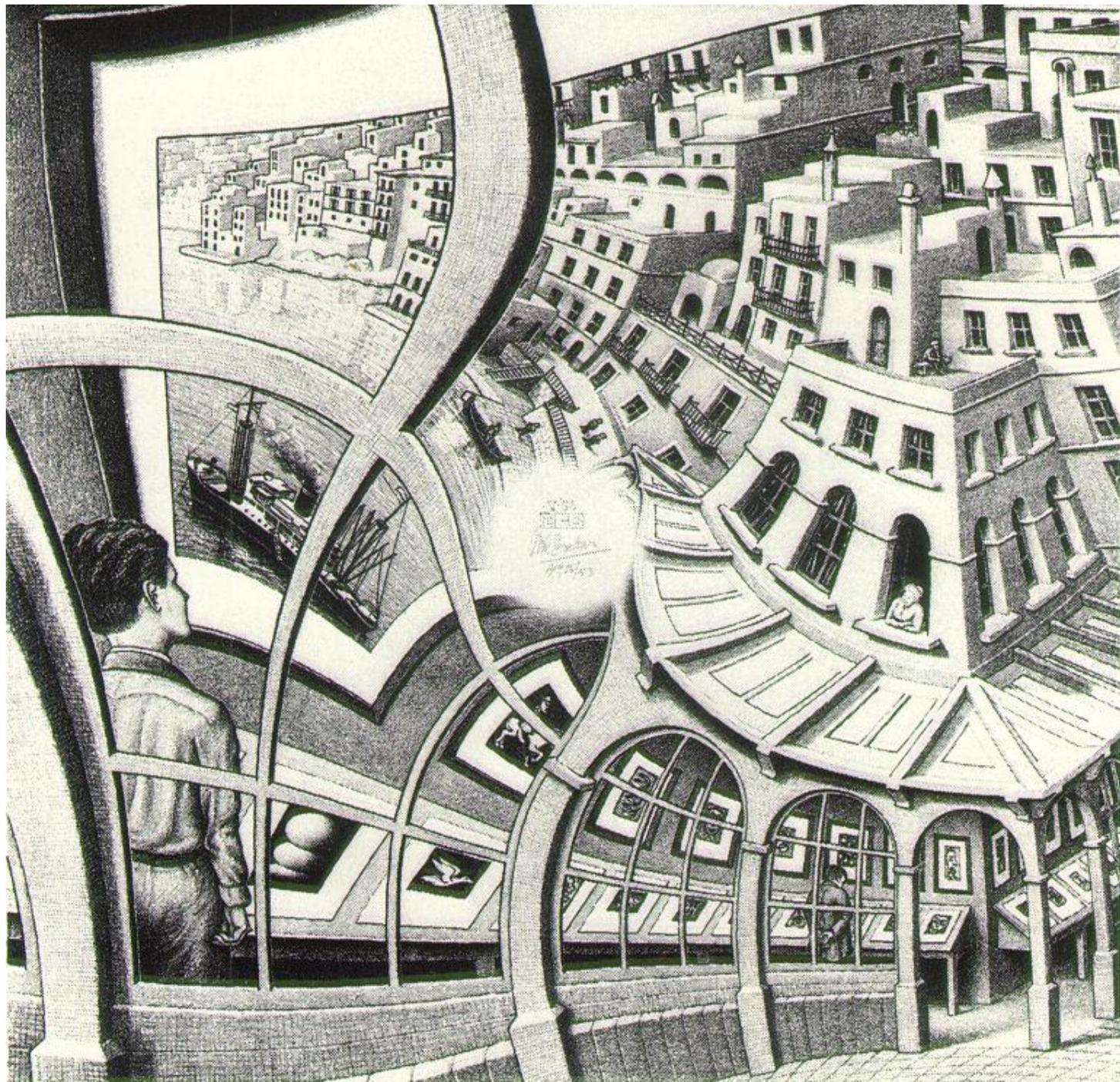


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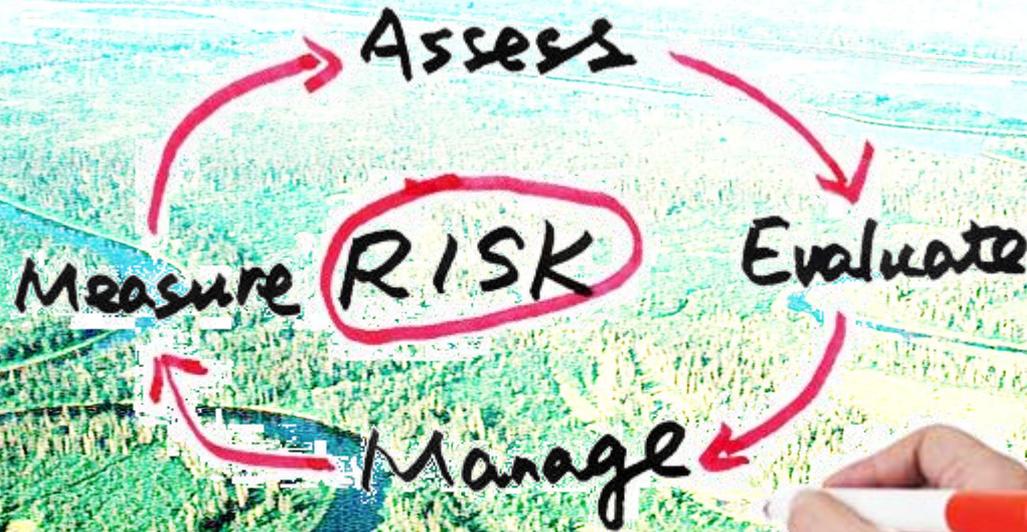


Issues

- **Sustainability of forest practices**
- **Maintaining productivity**
- **Maintaining resiliency, integrity, biodiversity**



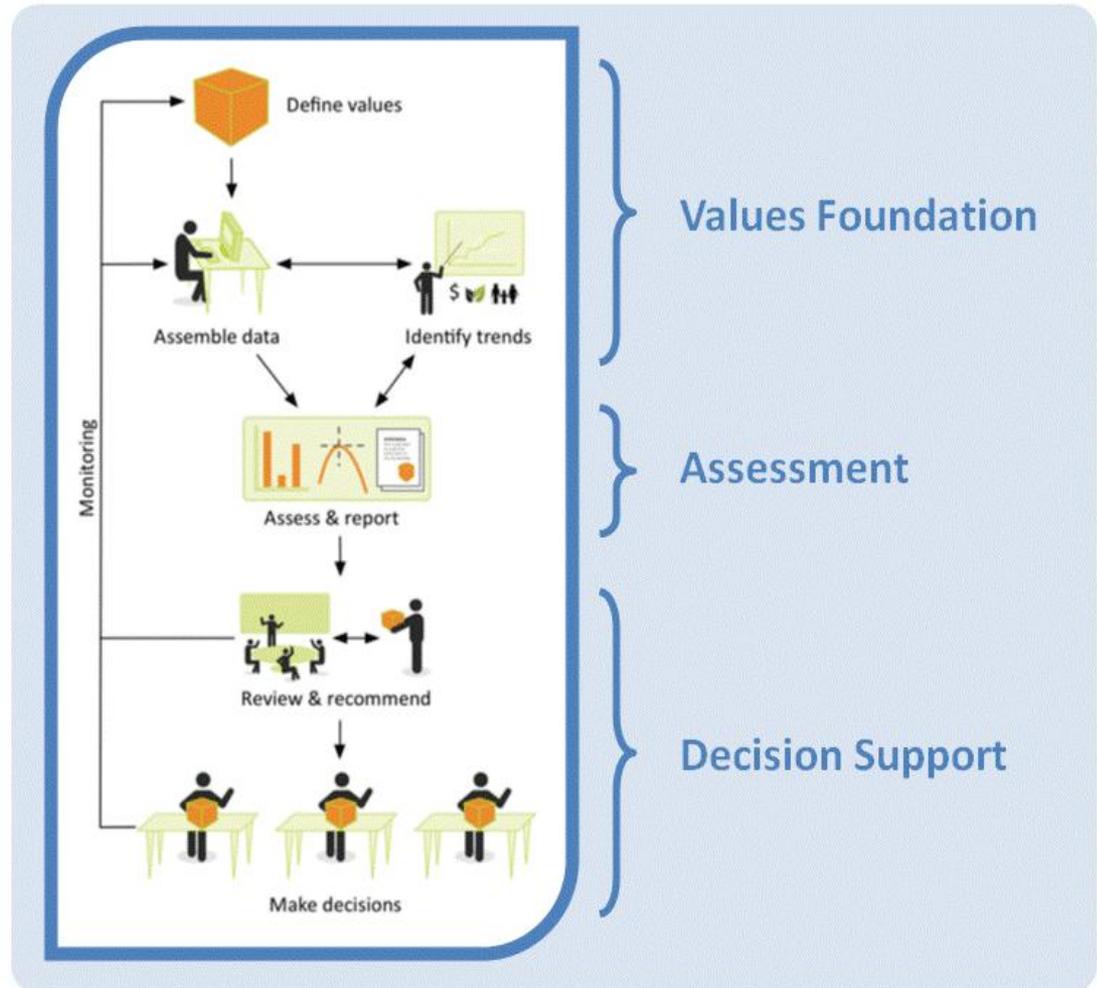
What's falling through the cracks?





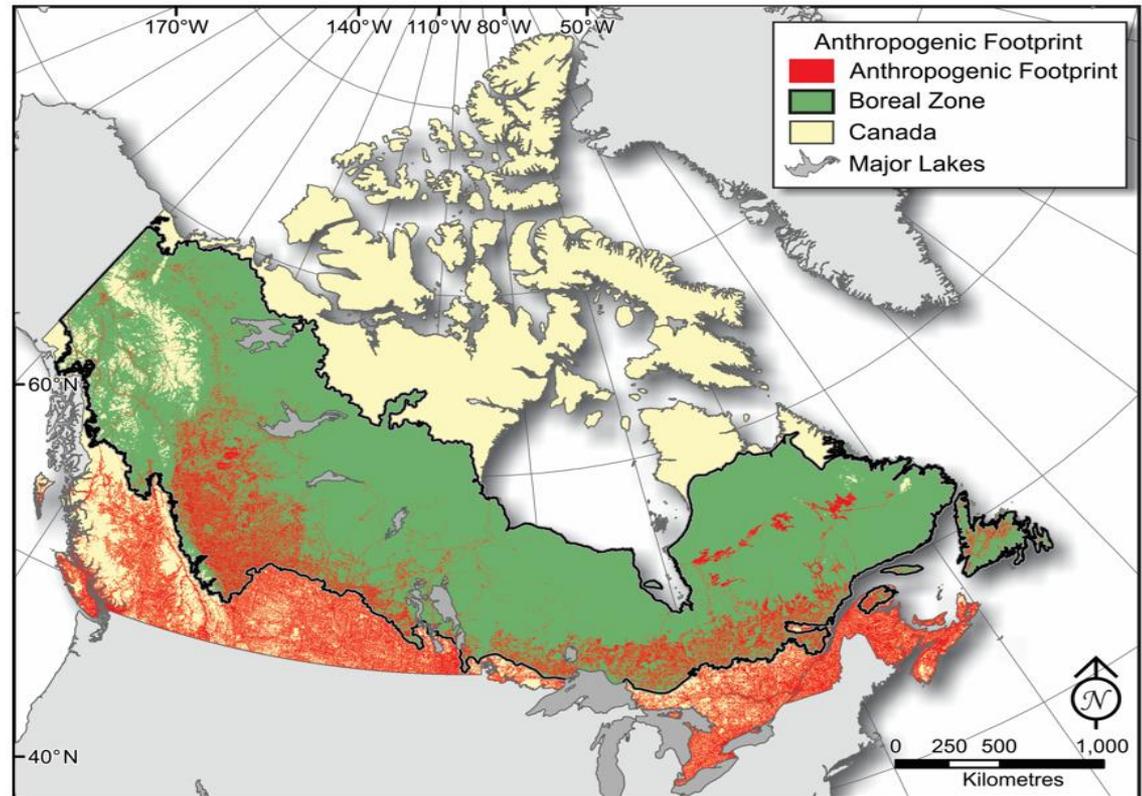
Addressing Cumulative Effects in Natural Resource Decision-Making A Framework for Success

CEF Overview Report February 2014



Canada's boreal forest ecosystem is at increasing risk from natural development activities

These activities are intensifying, expanding, and resulting in disruptions that deteriorate the **productivity** and **biodiversity** of the ecosystem.



Cumulative effects of natural resource extraction activities

- *If* undesirable changes are a result of the combined residual effects of human activities operating within the bounds of regulatory frameworks...
- *Then* our regulatory frameworks need to be improved.



Series of *Environmental Reviews* conclude that human activities are placing at risk the productivity and biodiversity of the Boreal ecosystem

Natural Resource Extraction: Forest cover is removed (e.g., for forestry, mining, energy) resulting in the loss of services provided by forests

Landscape Fragmentation: Parceling of the landscape into smaller pieces by the installation of roads, seismic lines, pipelines, railroads, and power corridors

Land Use/Land Cover Change: Demographic driven change in urban, agricultural and industry areas

Pollutants and Contaminants: Point source emissions and long-range transport of air and water pollutants related to industrial activities

Invasive (non-alien and) alien species: Elimination or displacement of native species by non-native species introduced deliberately or accidentally, causing ecosystem change or species loss

Technological practices: Certain practices of various industrial sectors may overwhelm the resilience of ecosystems to recover from disturbances



Why do ecosystem management policies fail?

Policy failures stem from **a gap** that exists between science and management.

Science is not effectively mobilized for consultation purposes in policy formation or understood by policy makers.

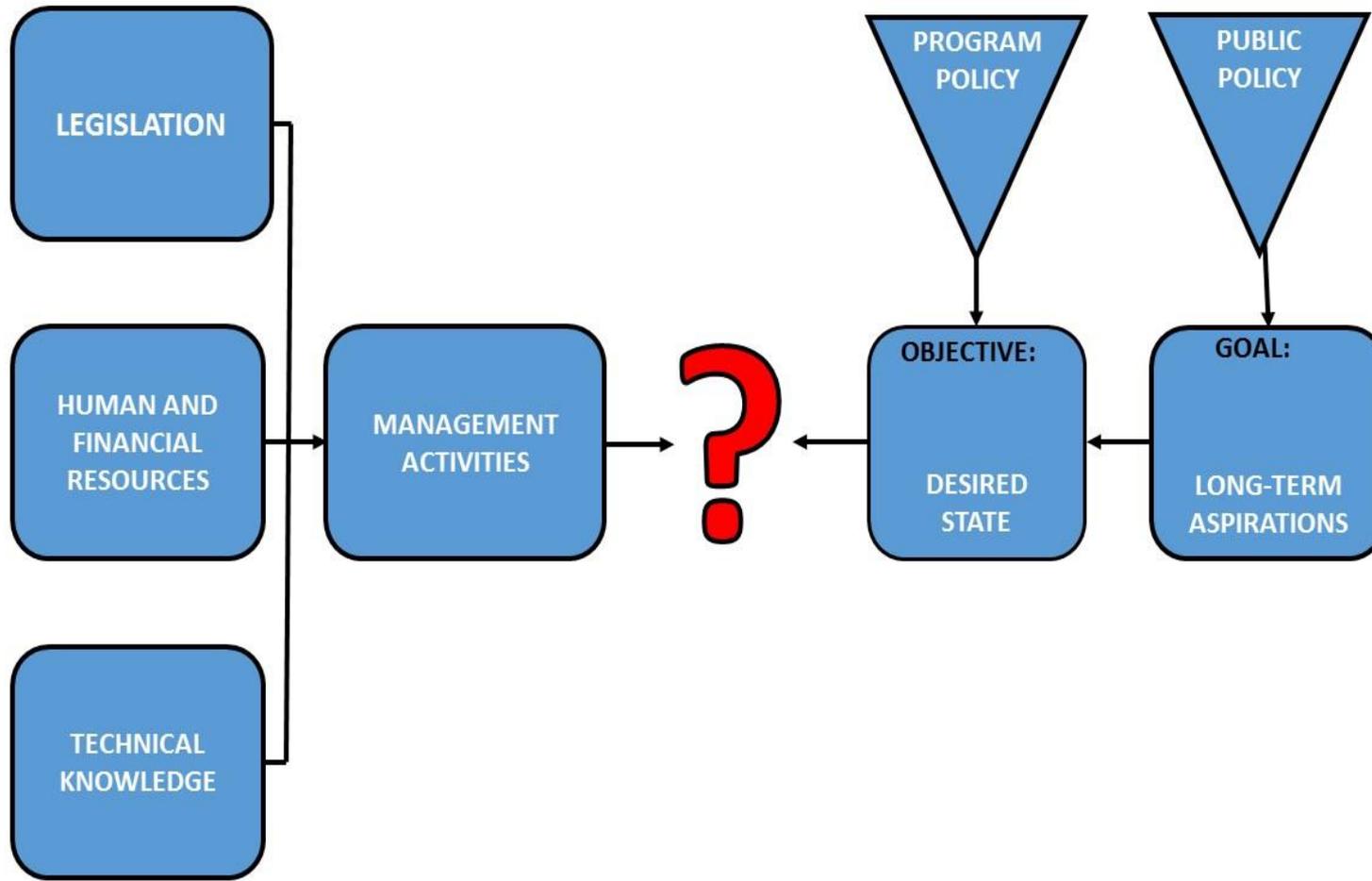
Management neglects to ask the appropriate questions to science in order to effectively improve legislation.

We recognize the need to **work within existing governance structures**.

We envision **a combined systems approach to link science and management** for the conservation of Boreal Forest productivity and biodiversity.



Why do ecosystem management policies fail?



Definitions: Risk, Assessment, Management

Risk: The effect of uncertainty on policy objectives.



Risk Assessment:

The likelihood, magnitude and severity of ecosystem impacts based on an understanding of the ecosystem science.

Risk Management:

The effectiveness of management measures at achieving ecosystem objectives.

This is achieved by improving controls to reduce the likelihood, magnitude and severity of ecosystem impacts, and by implementing recovery from ecosystem impacts.



Science vs. Management

Risk Assessment

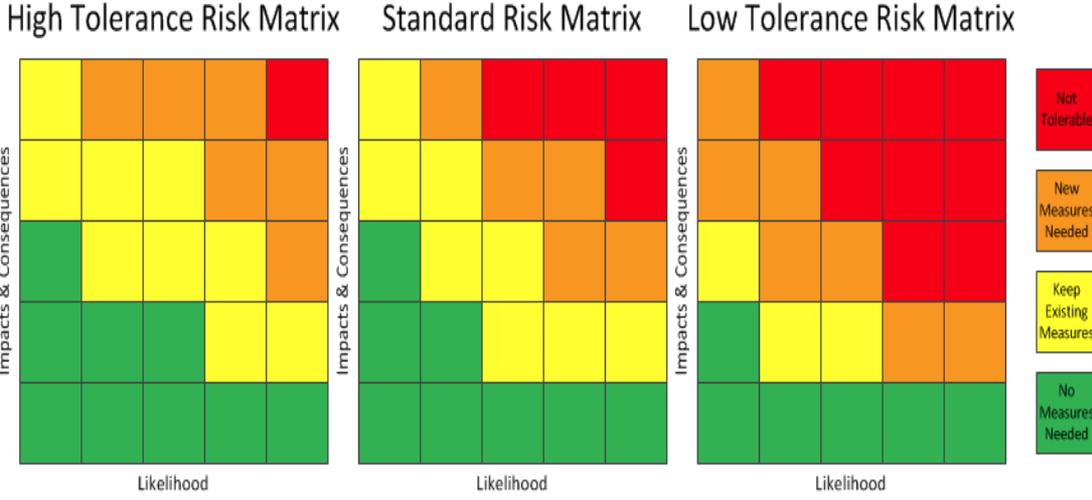
- Description of the ecosystem impacts
 - What can go wrong?
- **Likelihood** of the impacts
 - How likely is it to go wrong?
- **Magnitude** of the impacts
 - What could be the consequences of it going wrong?

Likelihood criteria				
A	B	C	D	E
Almost never observed-may occur only in exceptional circumstances	Has occurred infrequently before to others in similar circumstances	Has occurred here before, or has been observed in similar circumstances	Has occurred here more than once, or is occurring to others in similar circumstances	Occurs here regularly

Impact and Consequences criteria				
0	1	2	3	4
Pristine	Nominal response	Moderate response	Severe response	Catastrophic response

Risk Management

- Evaluate the **severity** of the impacts
 - How bad is it?
- Eliminate, avoid or control the **likelihood** of the impacts
 - What can be done to reduce the likelihood of it going wrong?
- Mitigate or restore from the **losses** caused by the impacts
 - What can be done to reduce the consequences of it going wrong?



Systems Approach to Science vs. Management

Science

- Build an understanding of the ecosystem
- Characterize ecosystem structure and function
- Predict likely ecological impacts

Management

- Establish objectives and outcomes
- Establish accountability
- Integrate ecosystem considerations in decision-making
- Develop and implement management measures



Definitions: Risk, Assessment, Management

Based on a **combined systems approach to link science and management**, the following are possible outcomes:

- (1) No management measures required;
- (2) Existing management measures adequate;
- (3) Existing management measures need enhancement; or
- (4) Additional management measures needed.



International Organization for Standardization (ISO)

What is a standard?

A standard is a document that provides requirements, specifications, guidelines or characteristics that can be used consistently to ensure that materials, products, processes and services are fit for their purpose.

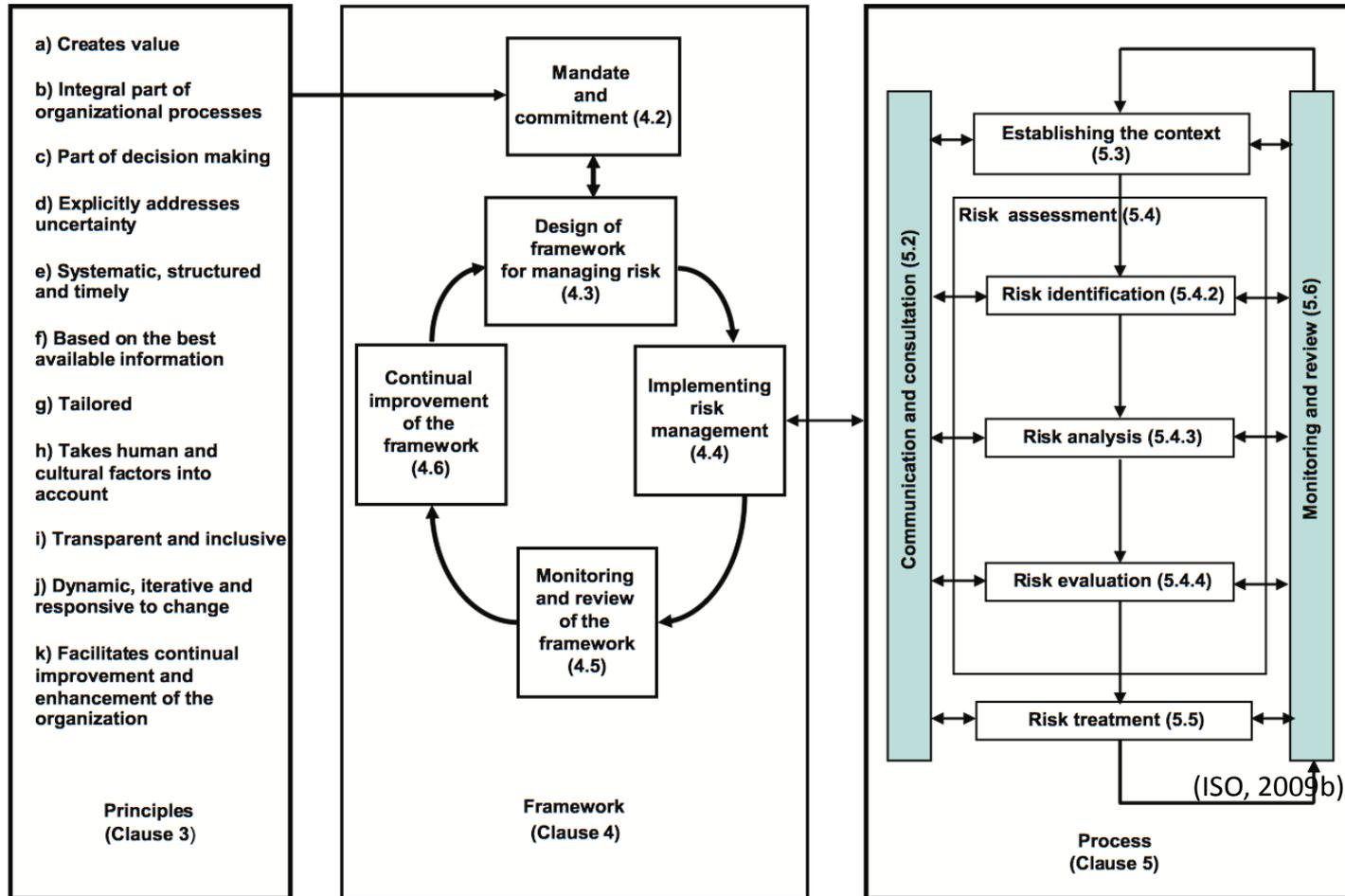
What are the benefits of ISO?

ISO International Standards ensure that products and services are safe, reliable and of good quality.

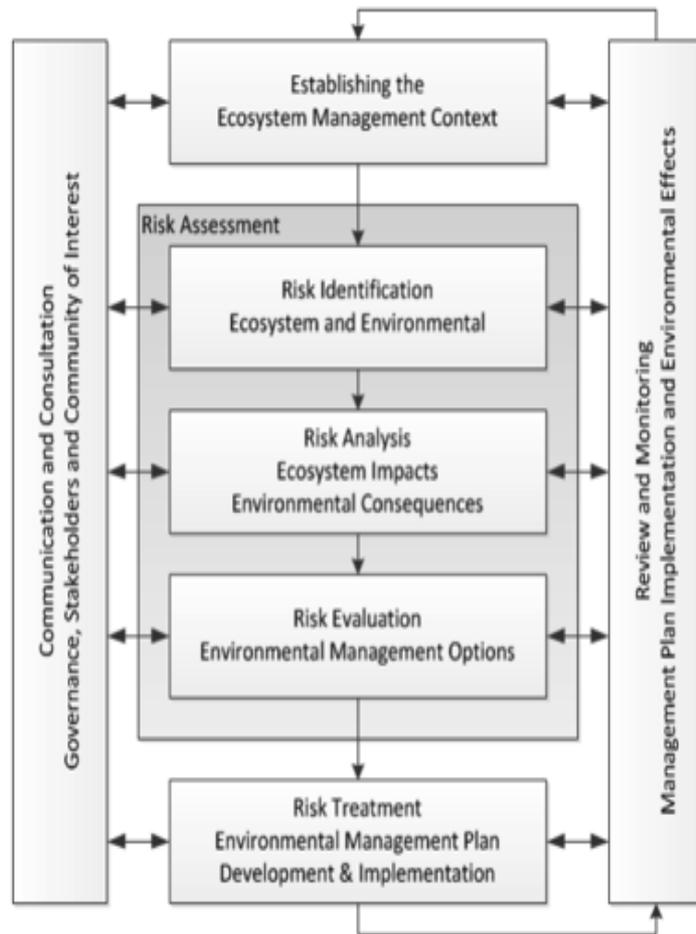


Risk Management Framework

ISO 31000:2009 (ISO, 2009b)



Risk Management Framework ISO 31000:2009 (ISO, 2009b)



Adapted: ISO 31000:2009

(Cormier et.al 2013)

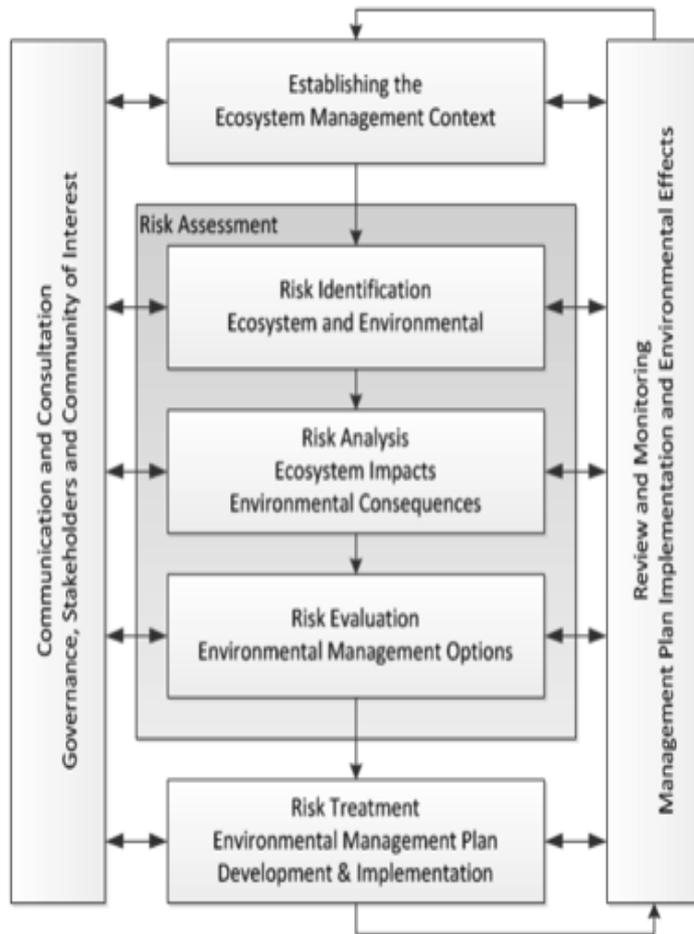
An evaluation of Canadian program activity shows the following allocation of resources:

- Establishing the ecosystem management context (31%);
- Risk identification (44%);
- Risk analysis (6%);
- Risk evaluation (6%); and
- Risk treatment (0%).

These steps are supported by **communication and consultation with governance, stakeholders and communities of interest** (6%), and **review and monitoring of management plan implementation and effects** (6%).



Risk Management Framework ISO 31000:2009 (ISO, 2009b)



- 75% of the resources are spent on establishing ecosystem management context and risk identification
- 12% on risk analysis, evaluation and treatment, and 12% on communication/consultation and review/monitoring.

Adapted: ISO 31000:2009

(Cormier et al 2013)



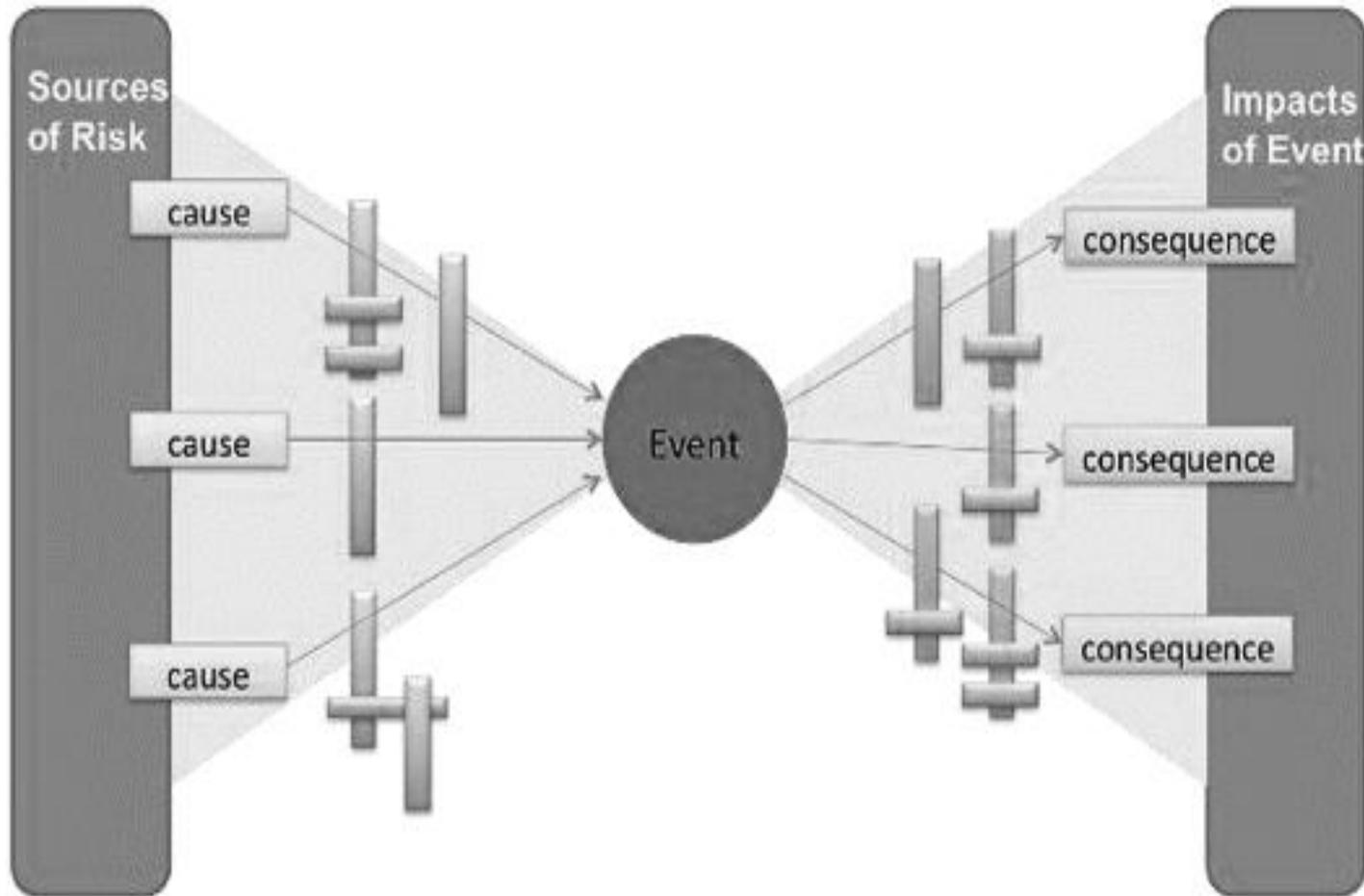
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Risk Analysis Tool

The Bowtie Analysis (ISO31010:2009)



The Bowtie Tool takes a **structured** and **systems** approach to risk analysis, evaluation, and treatment.



Bowtie uses a structured approach for managing ecosystem risks

Drivers – social, cultural, economic and political influences that drive human activities.

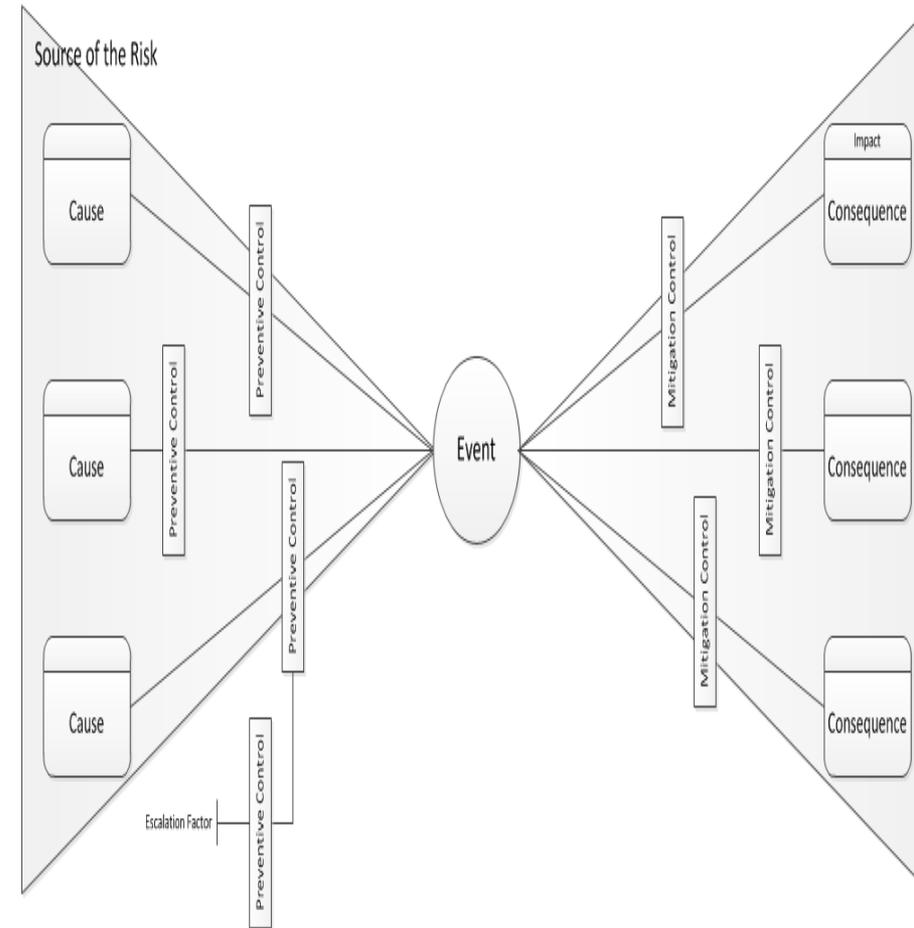
Causes – physical, chemical, or biological agents introduced or discharged into the ecosystem as the result of human activities.

Consequences – potential harmful impacts that may occur as a result of the risk event.

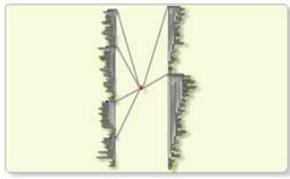
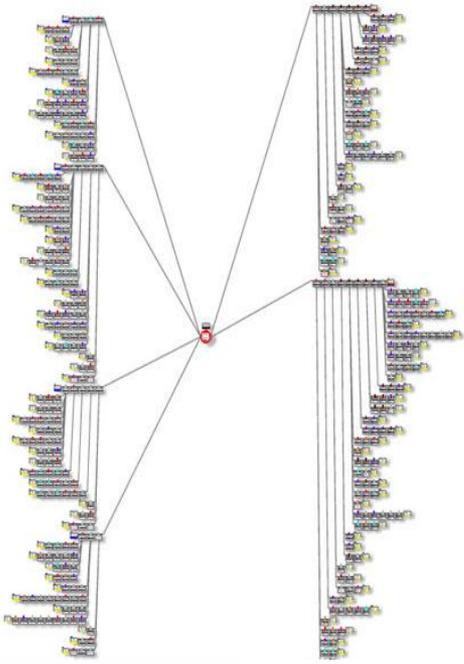
Prevention Controls – controls that reduce the likelihood of the causes of a risk event.

Mitigation Controls – controls that reduce the magnitude and severity of consequences after a risk event occurs.

Escalation Factors – undermine the effectiveness of prevention or mitigation controls; they focus attention to intrinsic design weaknesses as well as to outside



Hydrocarbons (Cargo)/Loss of Containment



Bayesian Belief Network

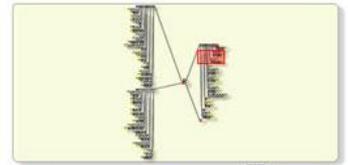
Risk Profile for Location < At Sea Condition >

Display Populated Risk Matrix

Code	Hazard	Top Event	Type	Consequence	P	A	E	R
H41.S02	Hydrocarbons	Loss of Containment in Cargo Tanks (Sea)	None	Hull flooding. Potential for loss of stability				

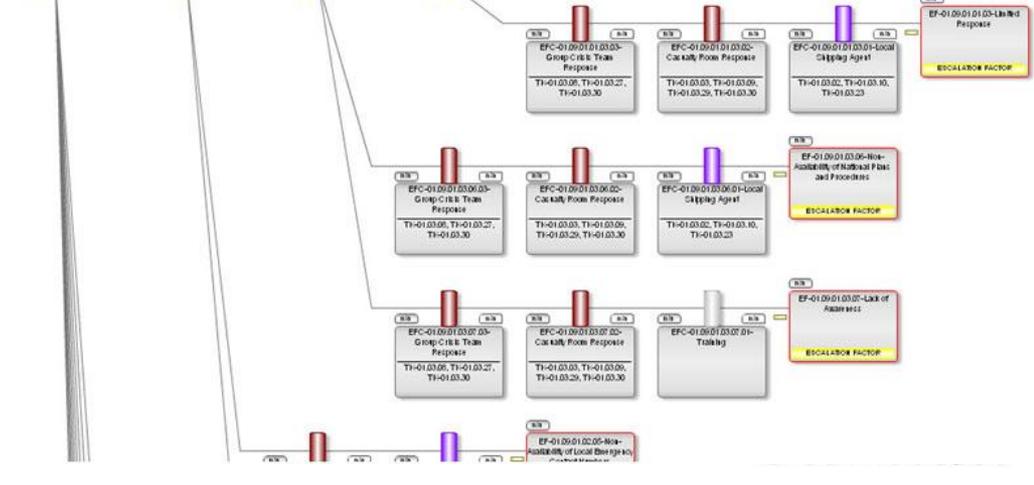
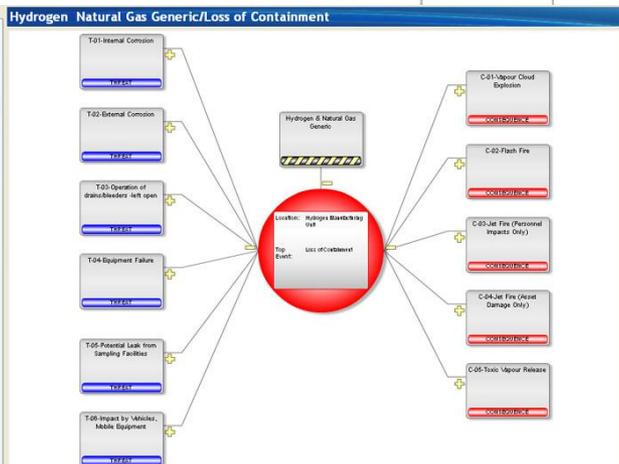
Risk Matrix

Severity / Likelihood	(A) Not Heard in Industry	(B) Has Occurred Once in Worldwide Fleet	(C) Has Occurred Once in Fleet of 1/1Y Worldwide	(D) Happens Once per Year in Fleet	(E) Happens Once per Year per ship
(0) No Damage			2		
(1) Slight Damage					
(2) Minor Damage			3		
(3) Localised Damage		2	4		
(4) Major Damage		4	6		
(5) Extensive Damage	2		2		



Case Tree / Reference Tree

- Generic BT H2 Manufacturing
 - Hydrogen Manufacturing Unit
 - Security Hazards
 - Business Risks
 - Health Effects
 - Environmental Aspects
 - Safety / Major Hazards
 - Hydrogen Natural Gas Generic/Loss of Containment
 - Threats
 - Internal Contamination
 - External Contamination
 - Operation of drains/bleeders left open
 - Equipment Failure
 - Potential leak from Sampling Facilities
 - Impact by Vehicles, Mobile Equipment
 - Consequences
 - Vapour Cloud Explosion
 - Flash Fire
 - Jet Fire (Personnel Impacts Only)
 - Jet Fire (Asset Damage Only)
 - Toxic Vapour Release
 - Shortfalls
 - Interface Activities
 - Activities



Bayesian Belief Network

An event is the result of **additive, synergistic** or **independent causes**.

The **Bayesian Belief Network** is a powerful tool for modeling decision-making under uncertainty.

The **Bayesian Belief Network** is a quantitative tool that uses expert feedback to model the pathways from causes to multiple consequences linking to some observable result, such as loss of productivity or biodiversity.



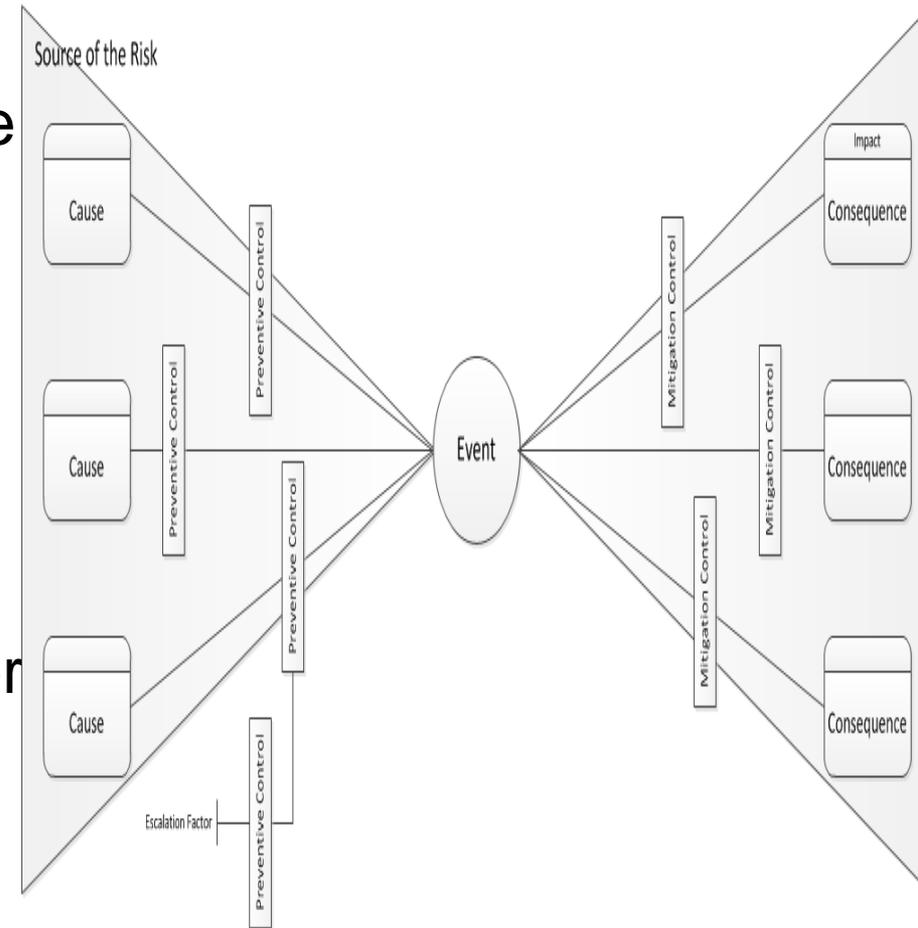
Risk Event for the boreal?

Productivity loss:

Loss of the capacity of a landscape to produce a merchantable resource within a reasonable amount of time (i.e., the rate of removal of renewable resources exceeds the rate of regeneration)

Biodiversity loss:

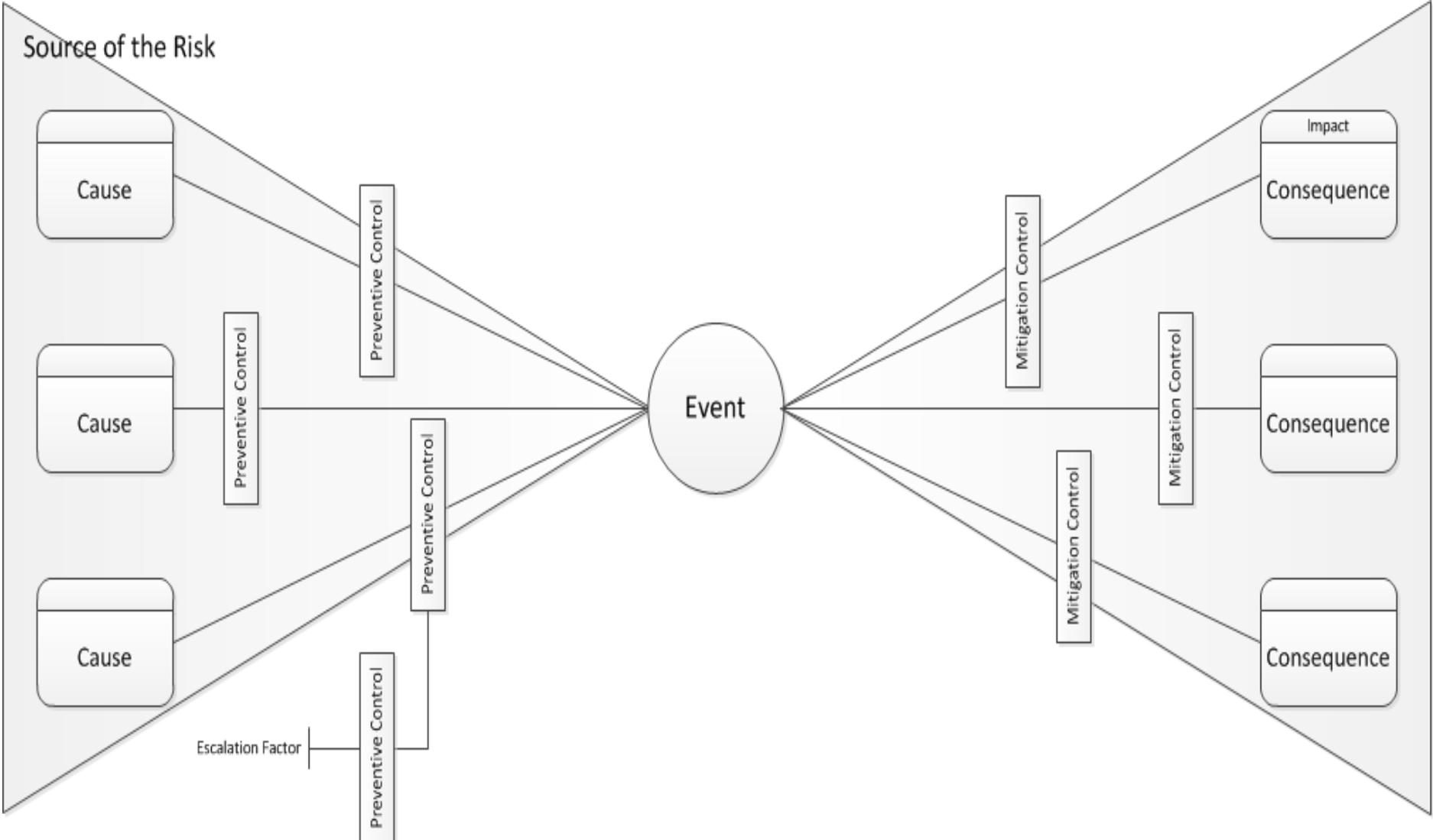
Loss of species (i.e., extractions) or reduction in species range, ecosystem simplification, ecosystem change, genetic loss, and reduced resilience



The gaps become apparent

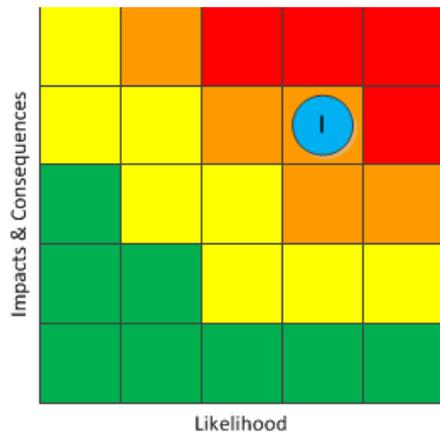
- Gaps in best available science needed to make decisions about cumulative impacts
- Gaps in policies, rules, and regulations needed to prevent policy failures
- Gaps in policies, rules, and regulations needed to mitigate policy failures
- Gaps in management of outcomes



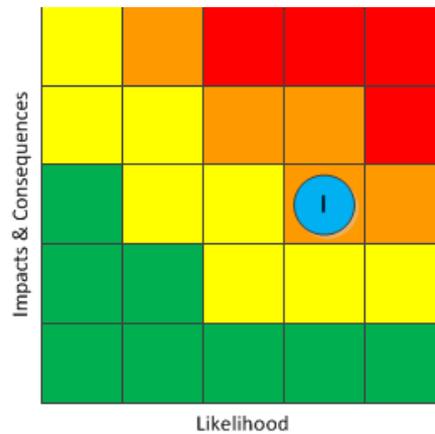


Risk Matrices

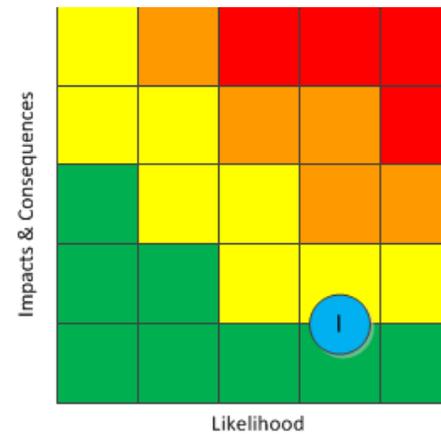
Ecological



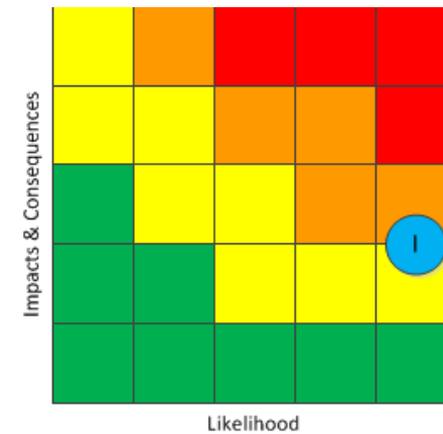
Social

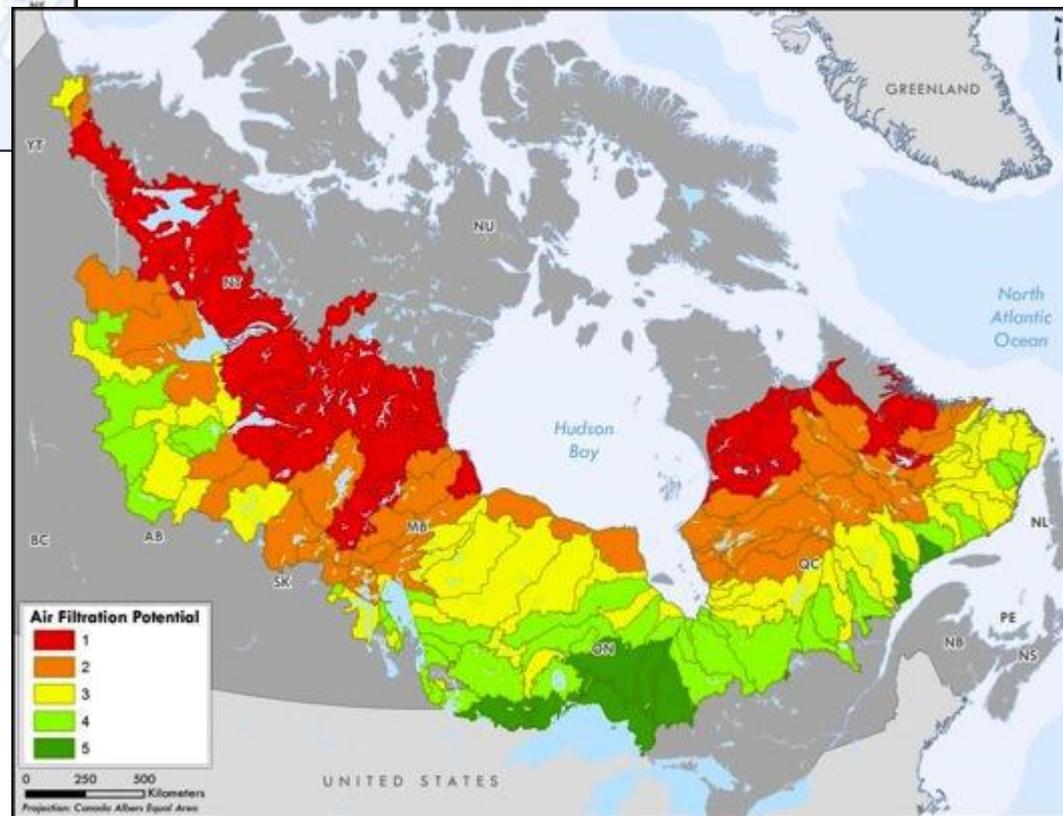


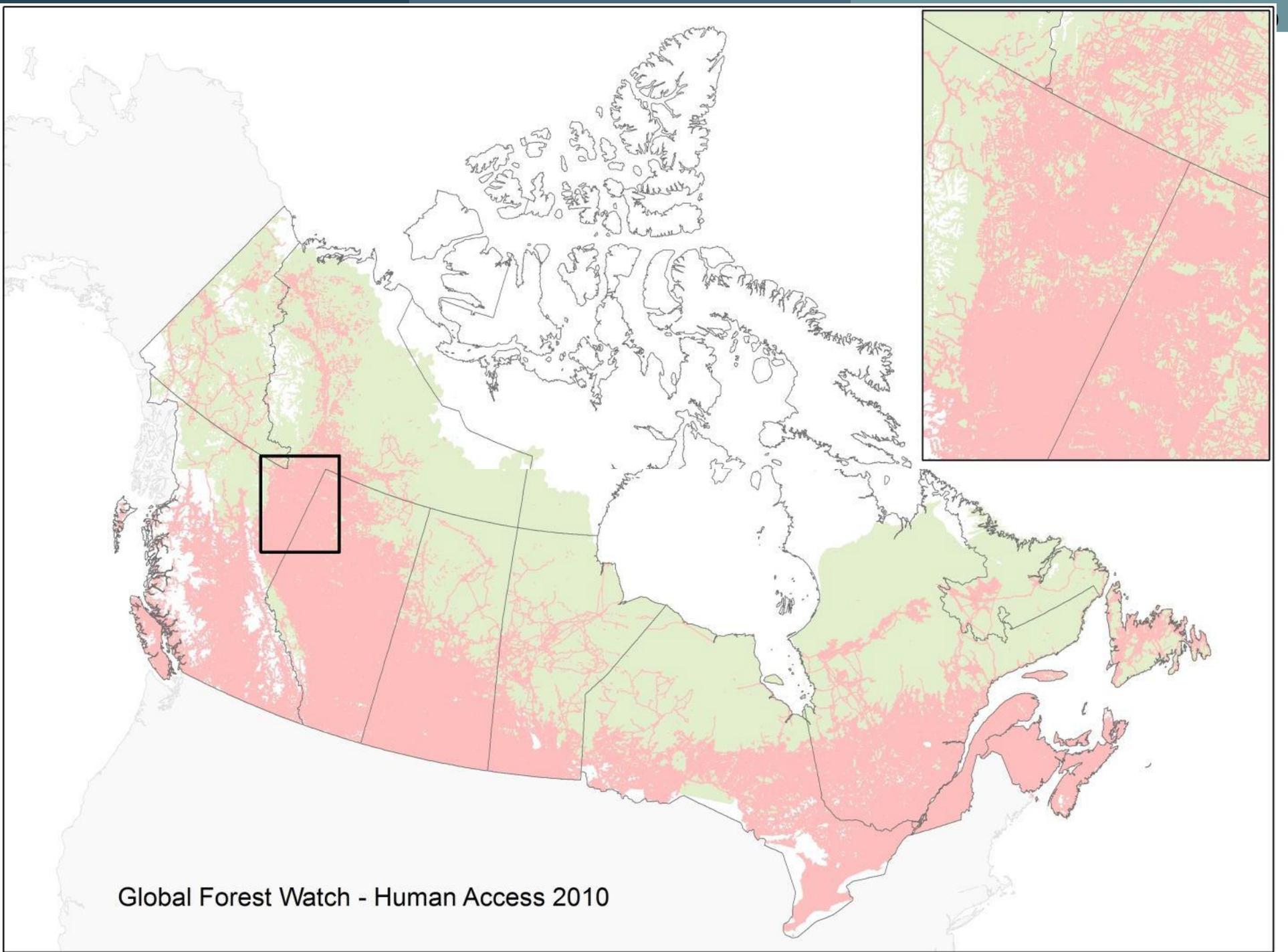
Economic



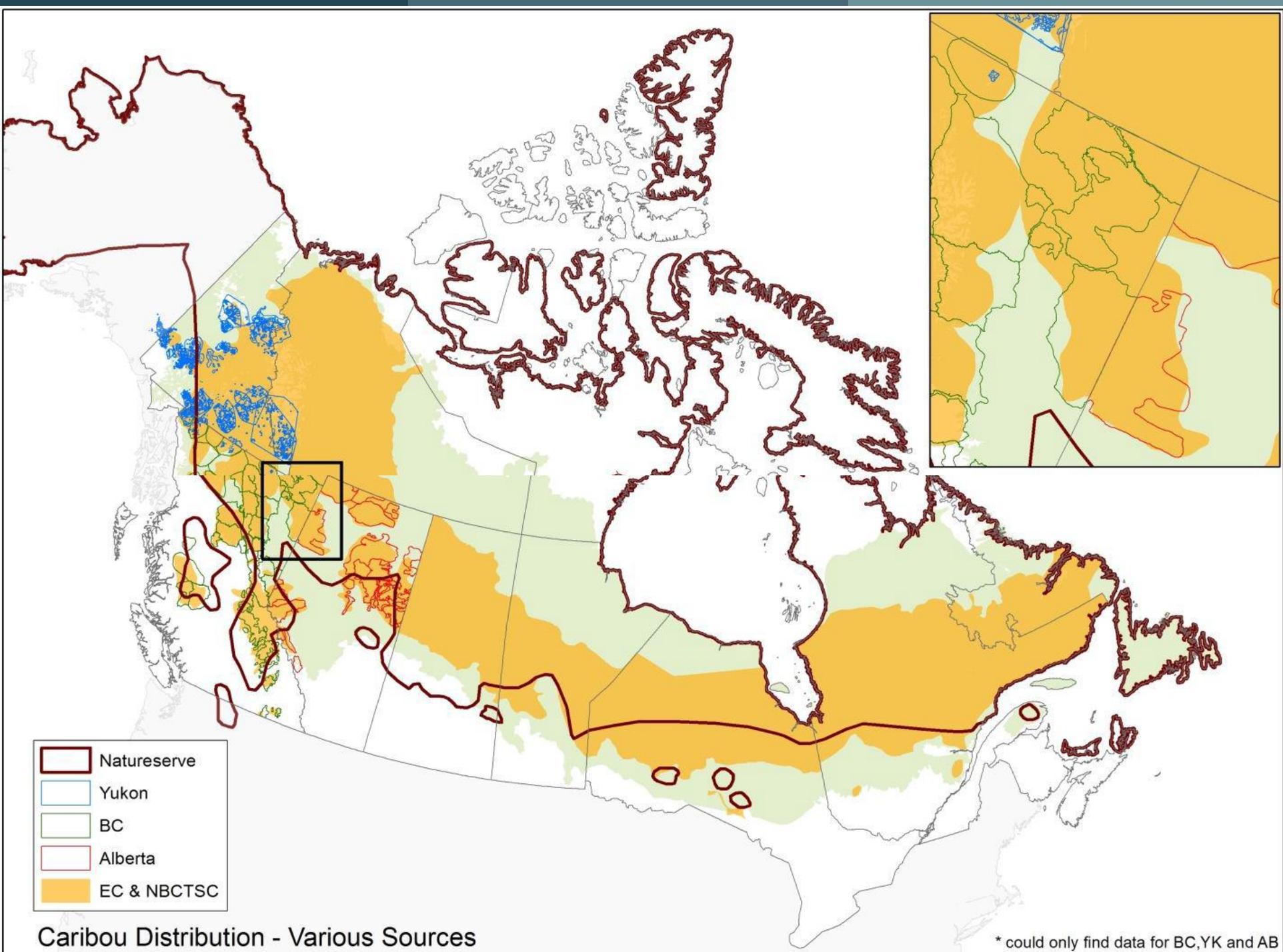
Political





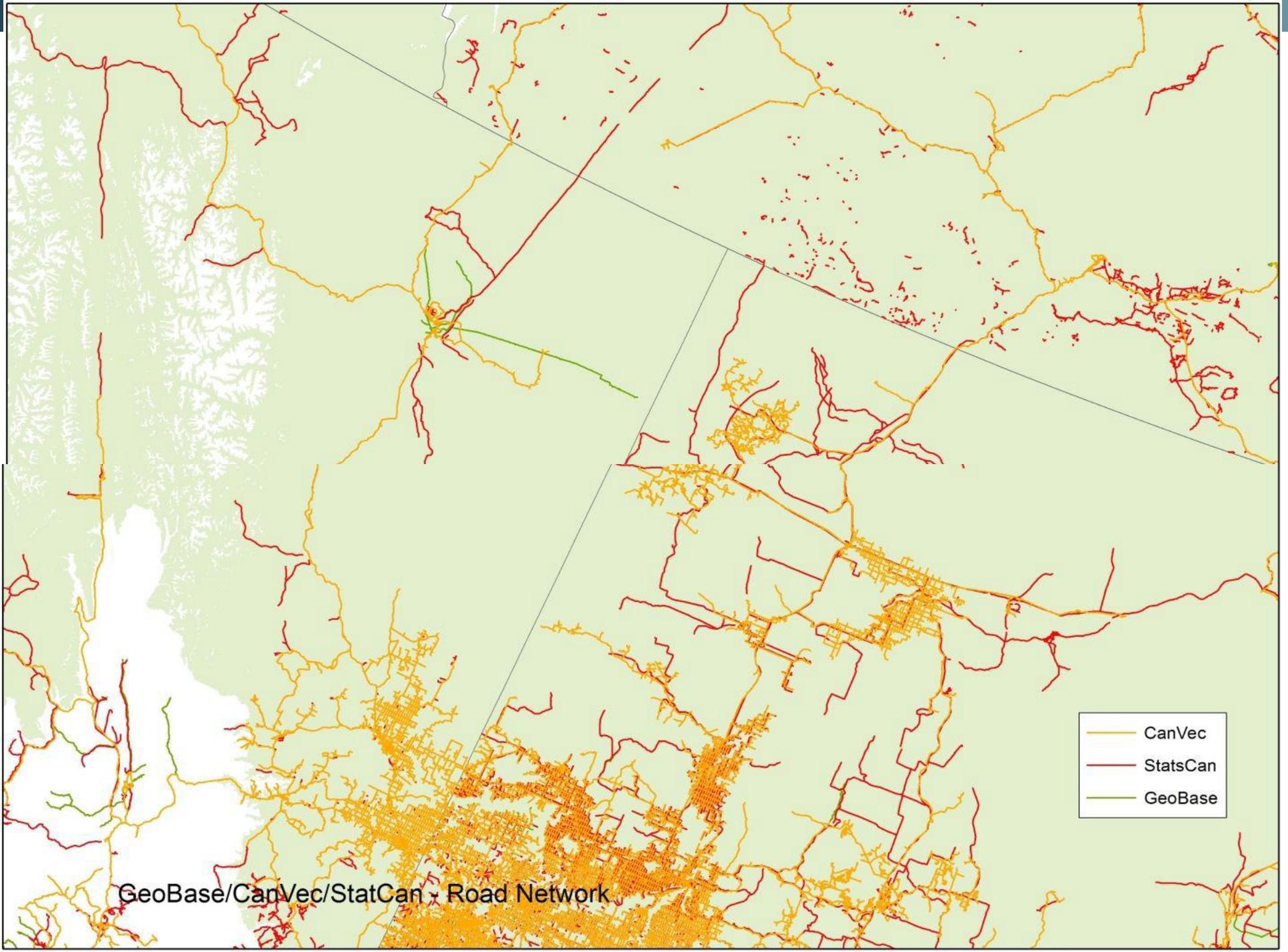


Global Forest Watch - Human Access 2010



Caribou Distribution - Various Sources

* could only find data for BC, YK and AB

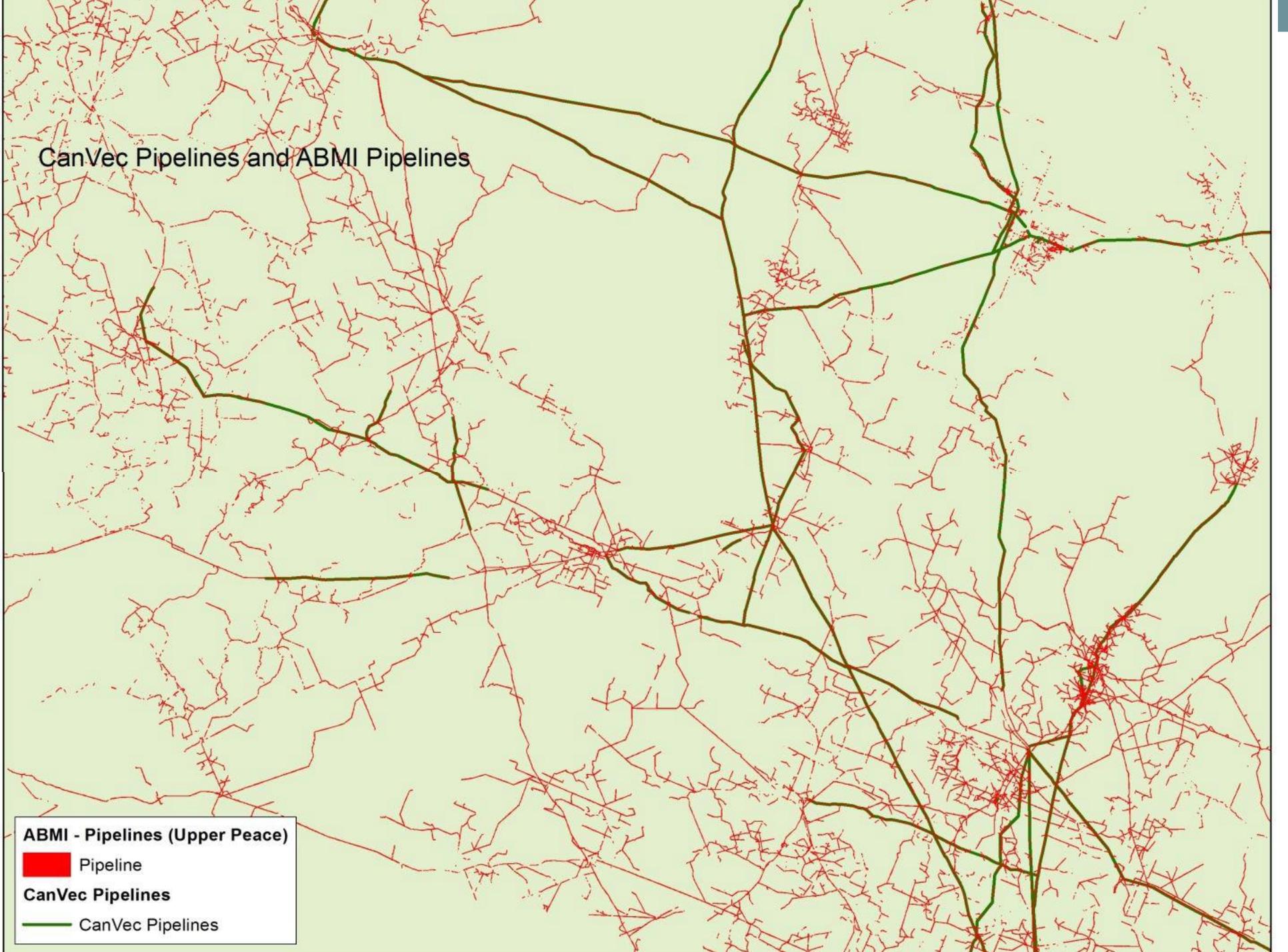


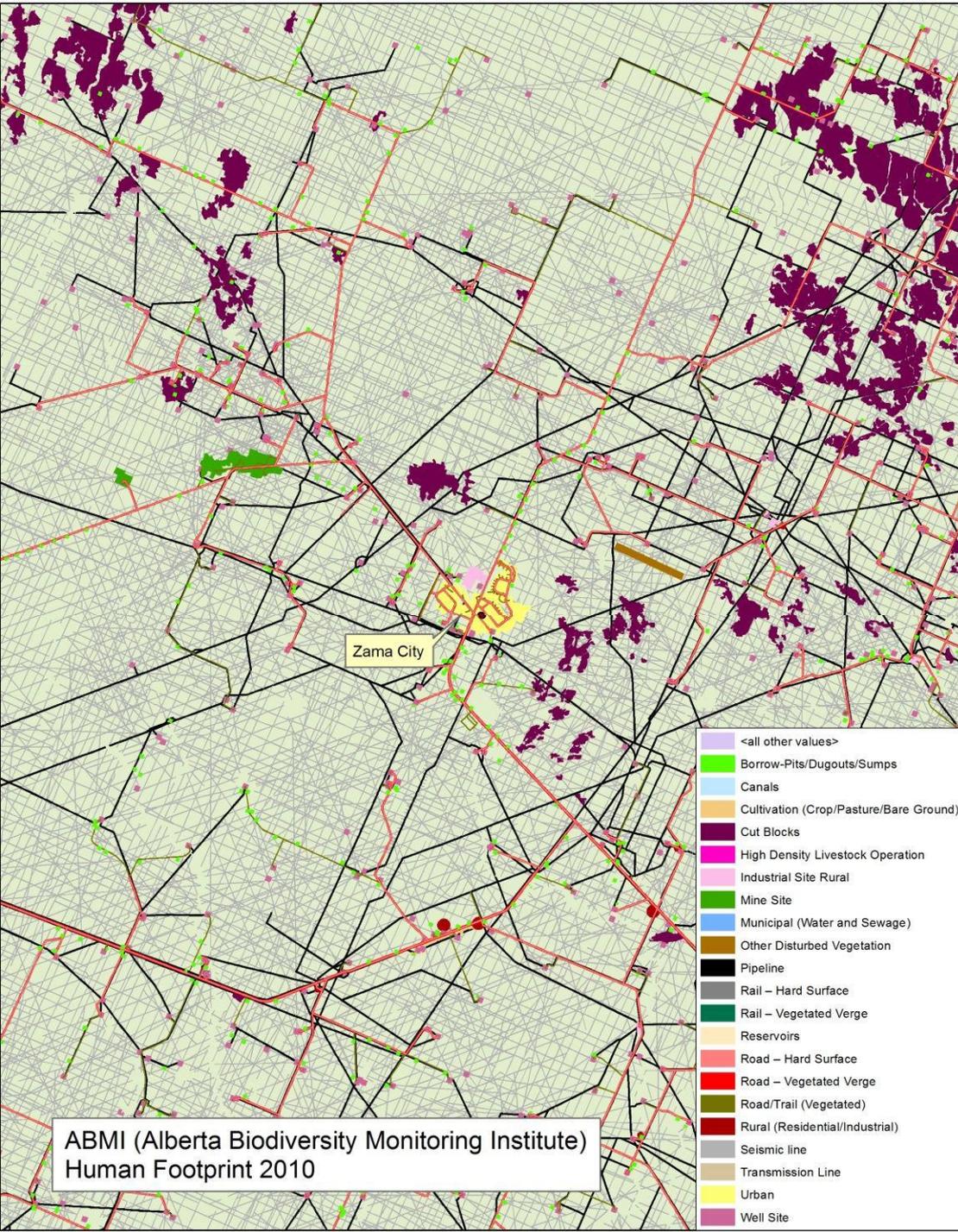
- CanVec
- StatsCan
- GeoBase

GeoBase/CanVec/StatCan Road Network

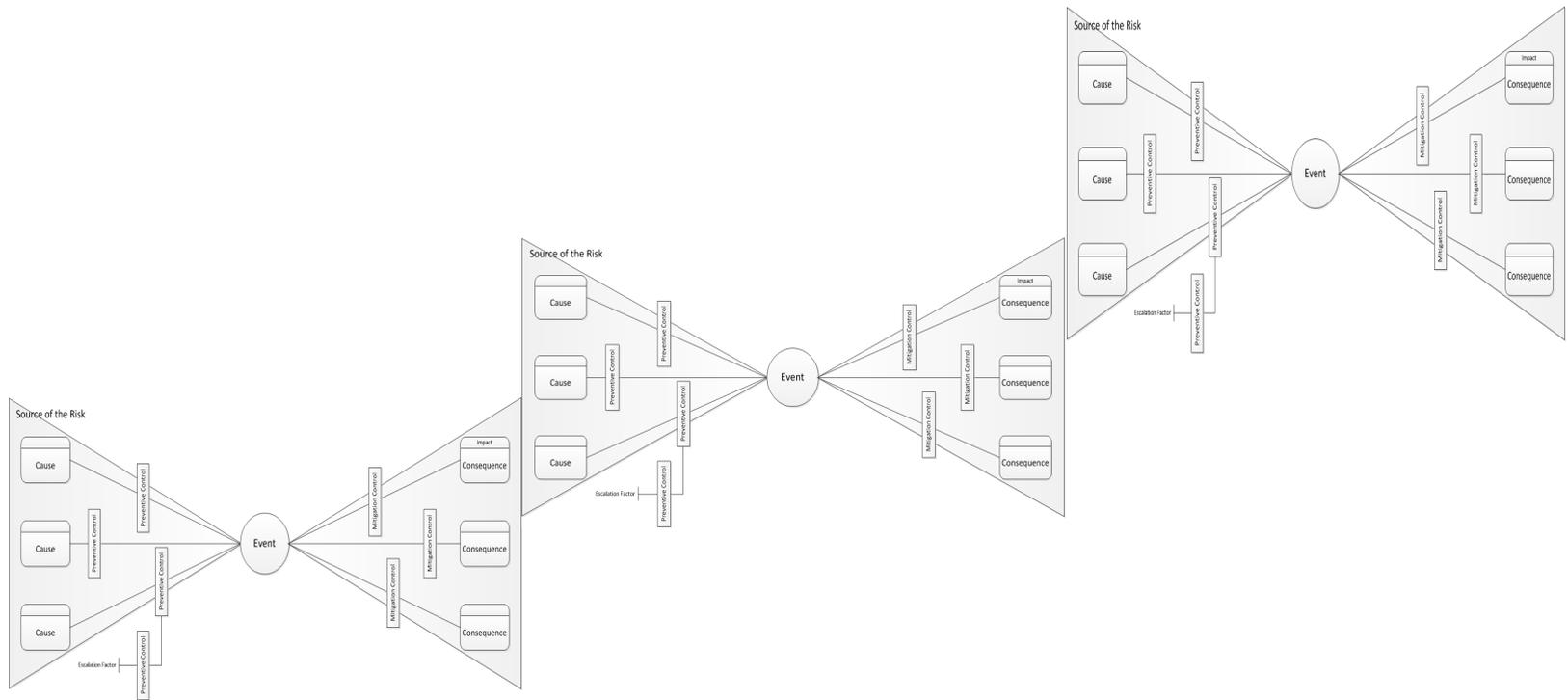
CanVec Pipelines and ABMI Pipelines

ABMI - Pipelines (Upper Peace)
 Pipeline
CanVec Pipelines
 CanVec Pipelines



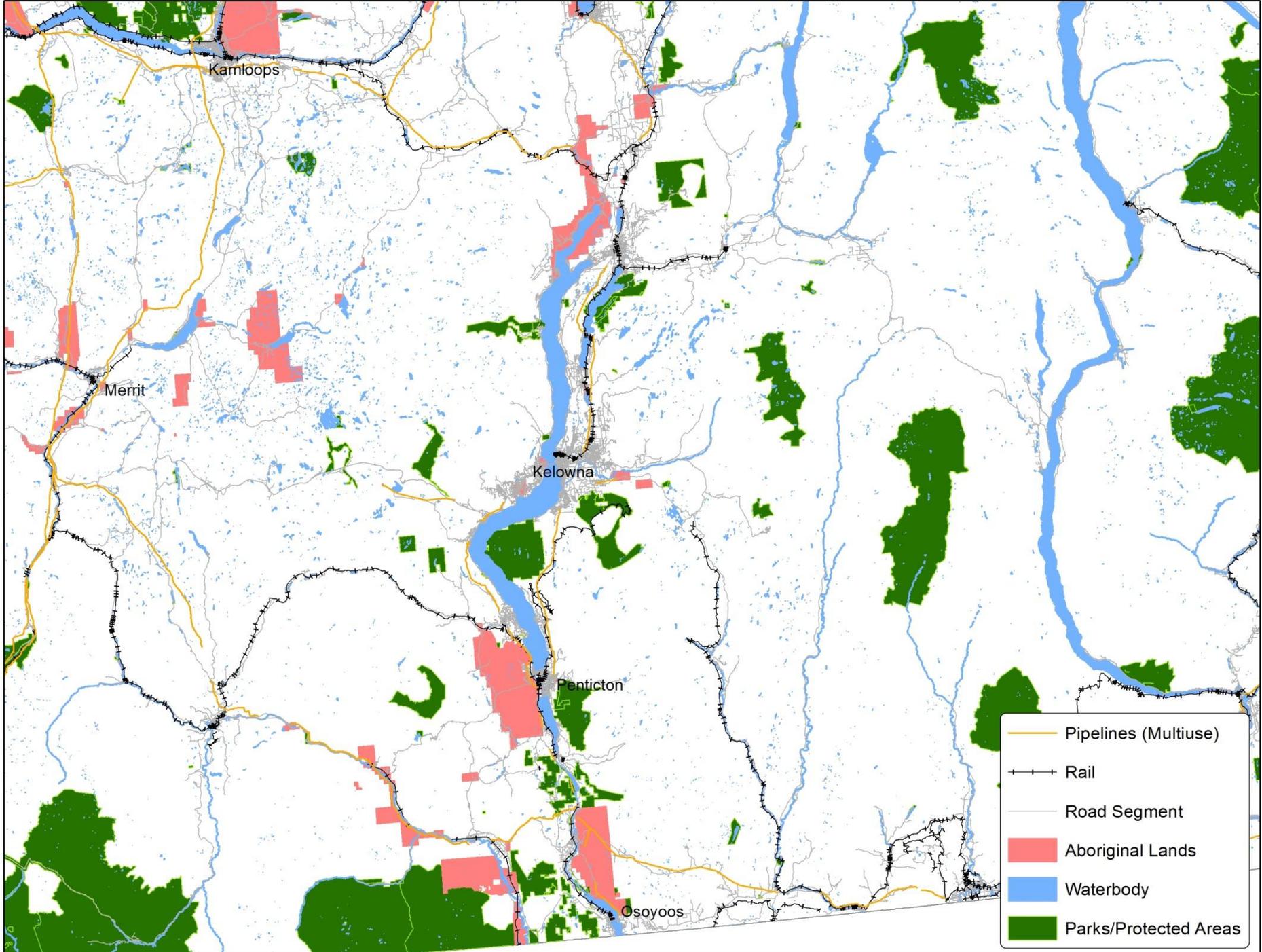


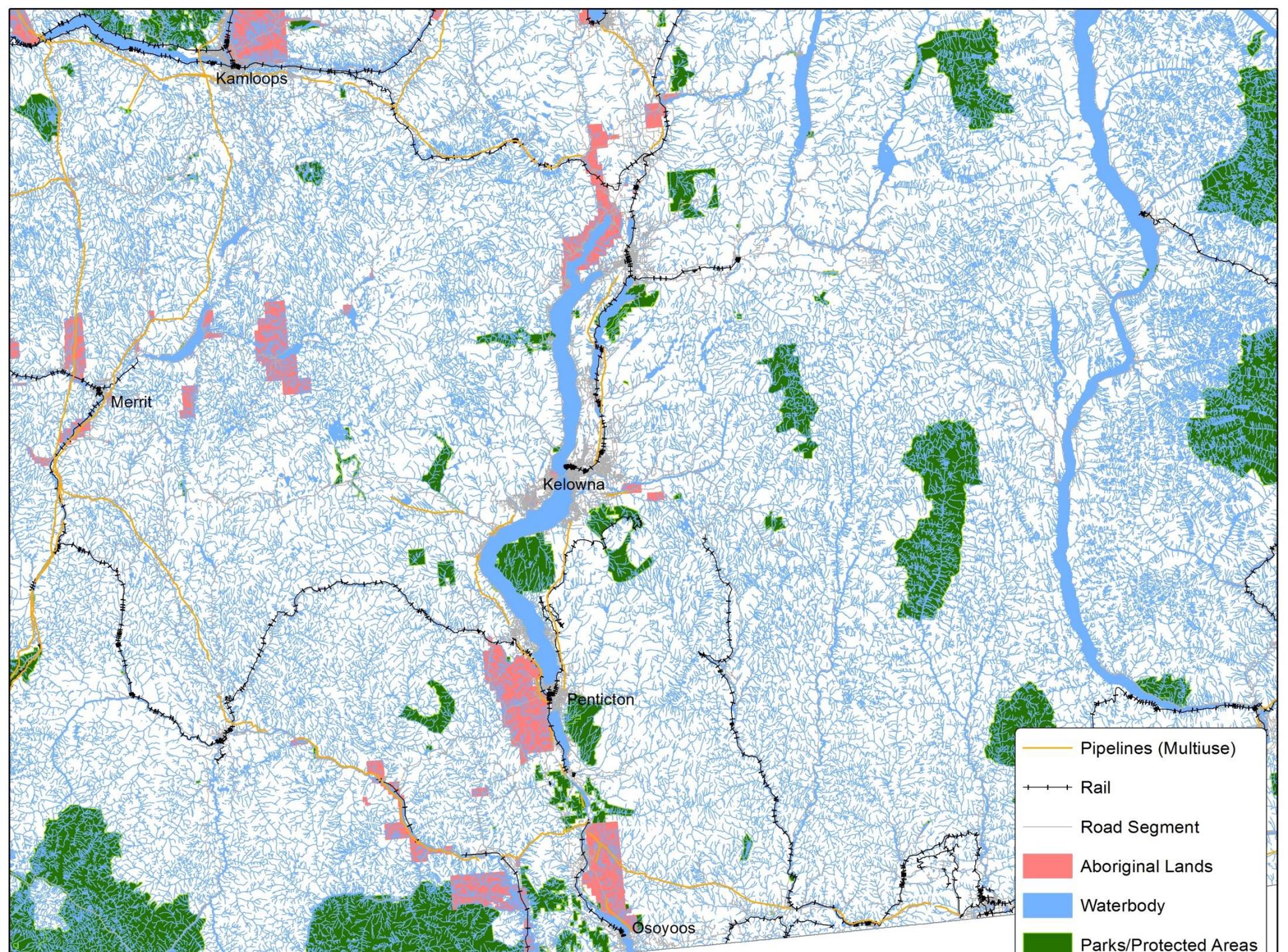
ABMI (Alberta Biodiversity Monitoring Institute)
Human Footprint 2010



Don't get lost in the weeds!







Kamloops

Merrit

Kelowna

Penticton

Osoyoos

- Pipelines (Multiuse)
- Rail
- Road Segment
- Aboriginal Lands
- Waterbody
- Parks/Protected Areas

