Maintaining a Balanced Moose-Wolf-Caribou System in Ontario's Ring of Fire Region

Using population dynamics modelling to support cumulative effects assessment and assessment and conservation planning

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Why This Matters

The Region Supports

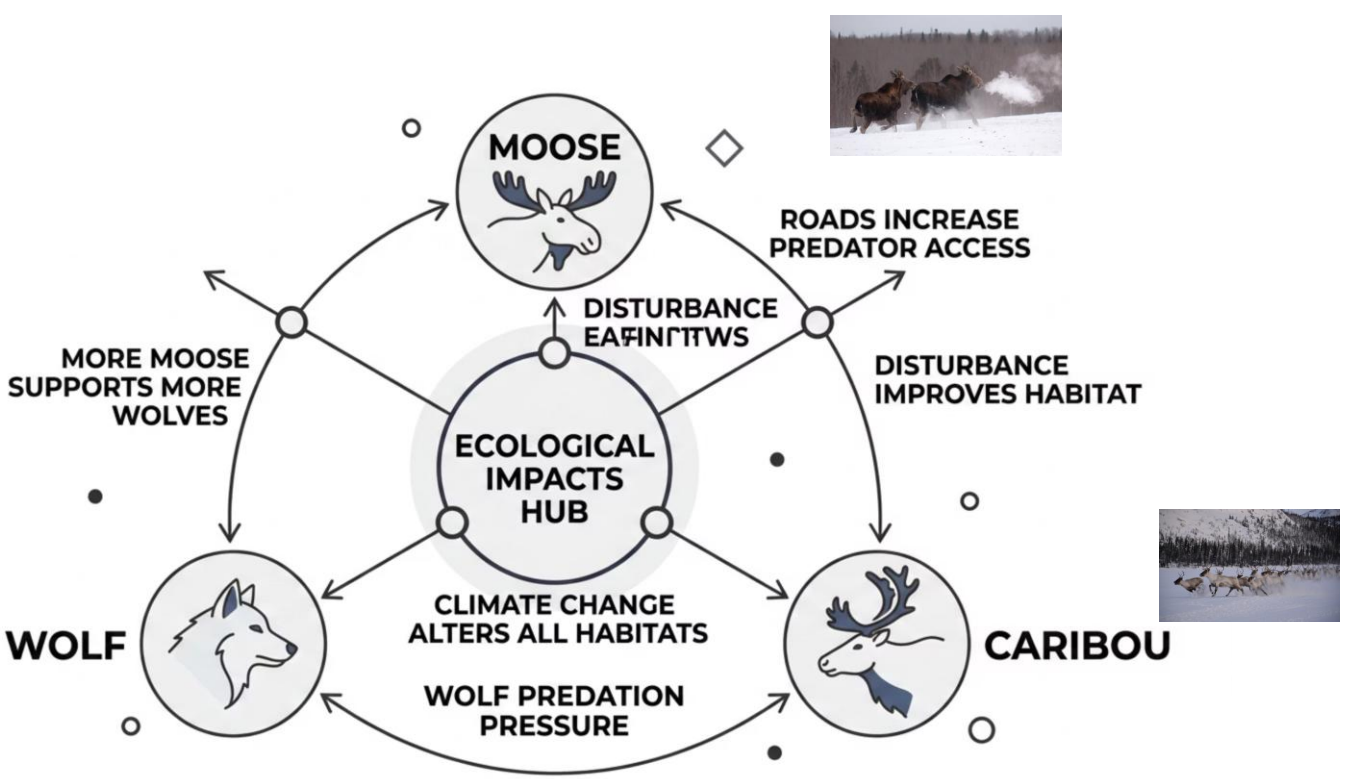
- Globally significant peatland peatland and wetland ecosystems
- Critical habitat for Boreal Caribou
- Healthy caribou and growing moose populations and wolf predator guilds
- Indigenous communities with deep cultural and subsistence ties to the land

Growing Pressures

- Mining development and transportation corridors
- Expanded resource access routes
- Climate change altering habitat suitability
- Changing wildfire patterns across the boreal

⚠ The challenge is not simply conserving one species — it is maintaining a healthy and balanced ecological system.

Systems Perspective = Understanding the whole web of relationships.
People, wildlife, water, forests, climate, and development are interconnected. Decisions should consider how changes in one part of the system affect the health and balance of the whole.



These cascading interactions create cumulative effects that demand a whole-system modelling approach — one that captures ecological feedbacks across space and time.

Why Regional Assessment Matters

Broad Ecological Processes

- Wildlife movement across multiple multiple caribou ranges
- Long-term forest succession dynamics
- Climate-driven habitat change over decades
- Predator-prey population cycles

Our Modelling Scope

- Broad regions, e.g., Combined Ozhiski and Mississa caribou ranges
- Full moose-wolf-caribou system integration
- Future projections extending **60 years** forward
- Multiple cumulative development scenarios

Assessment Consistency

This spatial and temporal scale is explicitly aligned with the goals of regional environmental assessment — capturing effects that single-project reviews routinely miss.

Development and Climate Change

Both stressors individually alter system dynamics — but their **interaction** is often more consequential than either acting alone. either acting alone.

Development Effects

- Habitat loss and fragmentation from industrial footprint
- Increased road access enabling greater predator movement
- Altered predator-prey encounter rates near corridors

Climate Effects

- Changing fire regimes reshaping boreal vegetation
- Shifts in plant communities affecting forage availability availability
- Changes in moose habitat suitability and distribution

When development opens access into climate-stressed habitat, cumulative pressure on caribou populations can populations can exceed what either stressor would produce independently.

Population Dynamics Modelling

To understand these complex interactions, we developed an integrated moose-wolf-caribou population dynamics model that synthesizes multiple ecological drivers into a single analytical framework.

Habitat Conditions

Landscape-level habitat quality and disturbance inputs across the modelling domain

Population Dynamics

Species-specific demographic rates, survival, and reproduction linked to habitat state

Predator-Prey Interactions

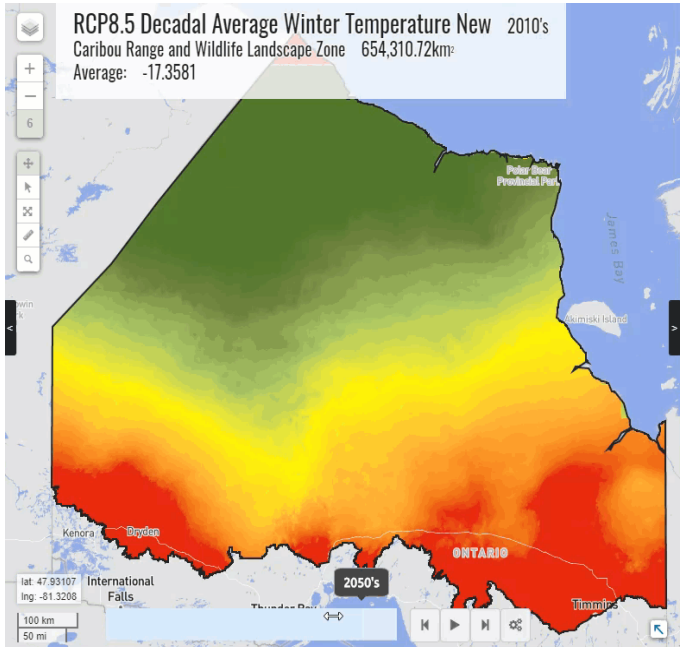
Functional response relationships between wolves, moose, and caribou populations

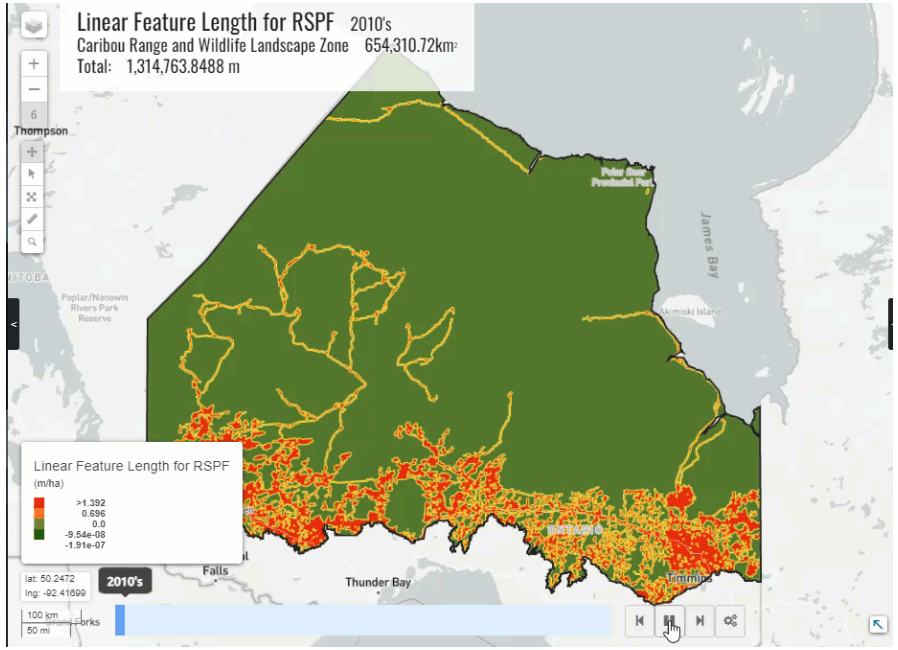
Scenario Exploration

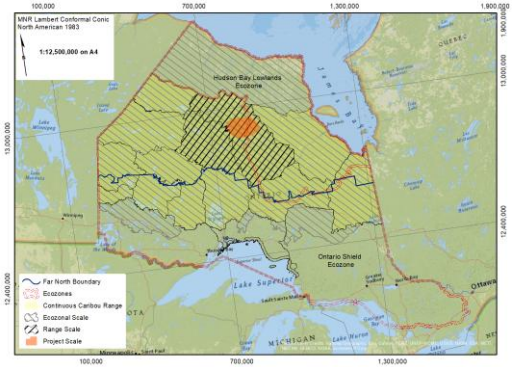
Disturbance scenarios and climate projections tested to evaluate alternative management outcomes

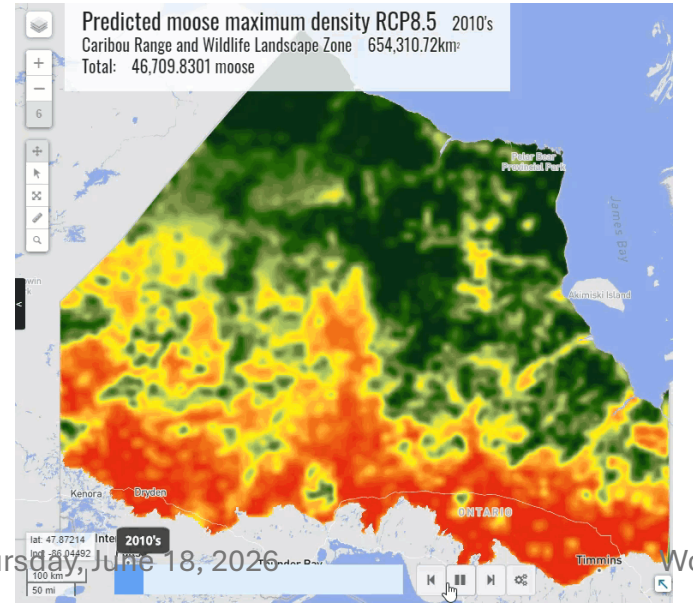
The objective is not to predict a single future — it is to explore possible futures and evaluate alternative management management strategies under uncertainty.

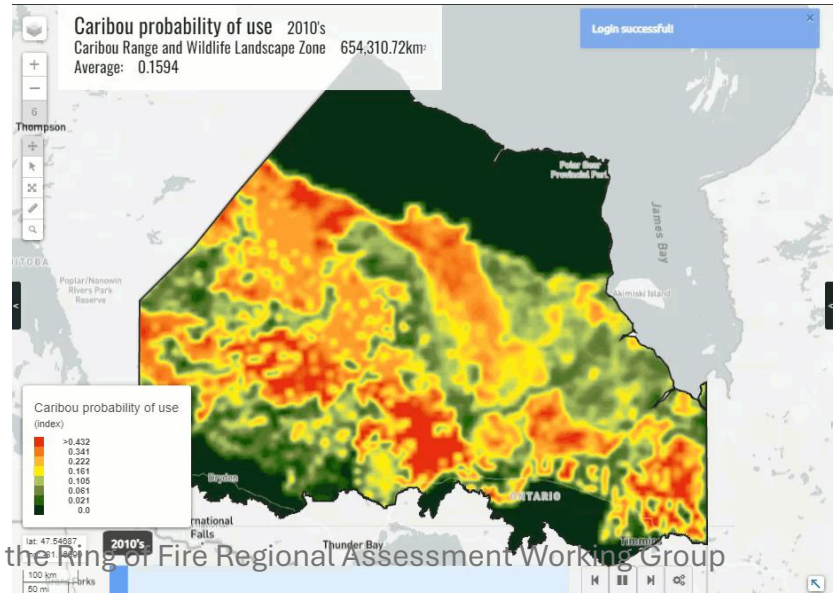
Scenario Animations











An assessment of mitigation strategies for maintaining a balanced moose-wolf-caribou system in Ontario's ring of fire region

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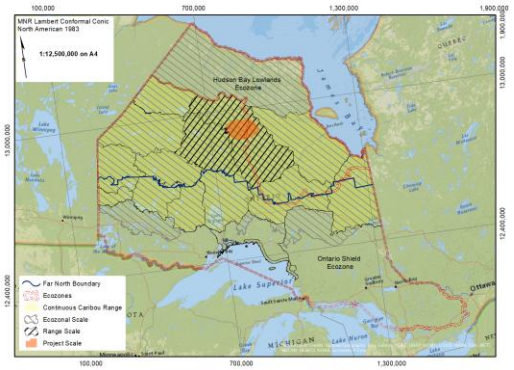
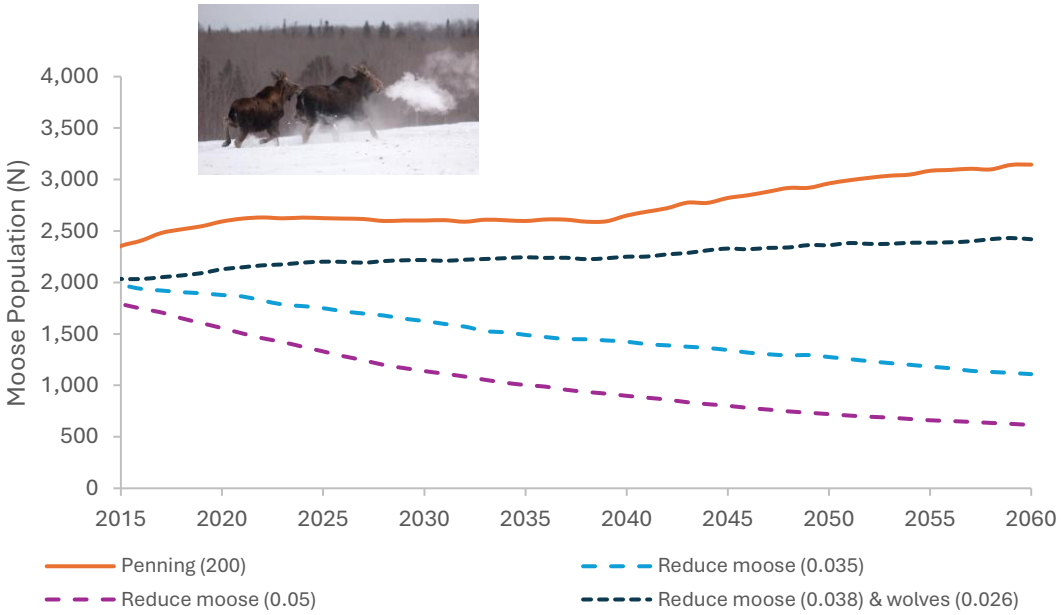
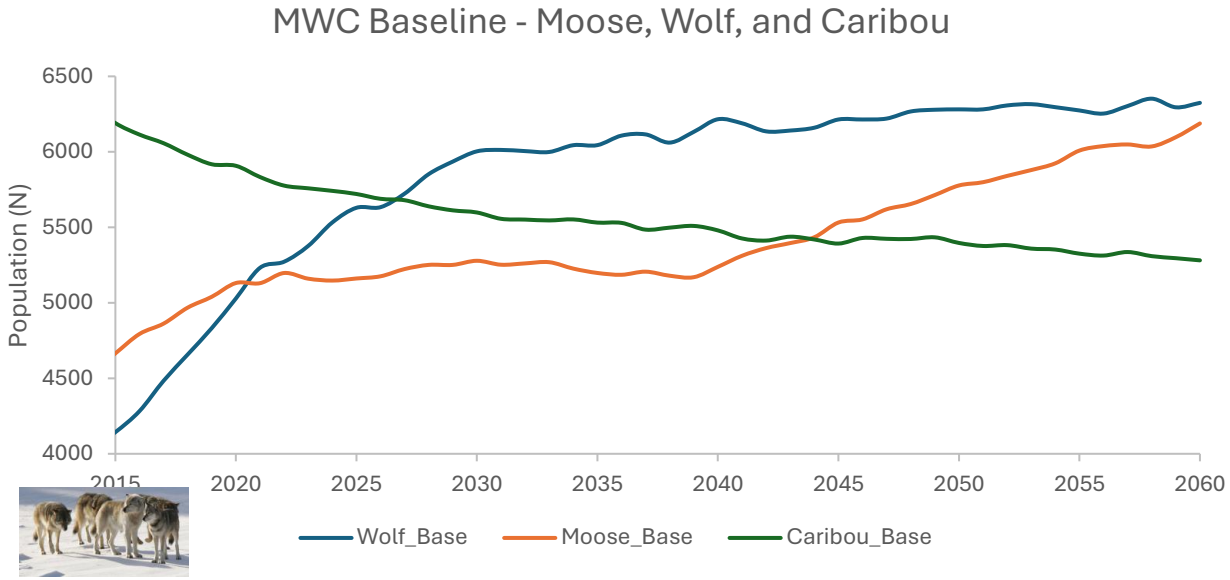
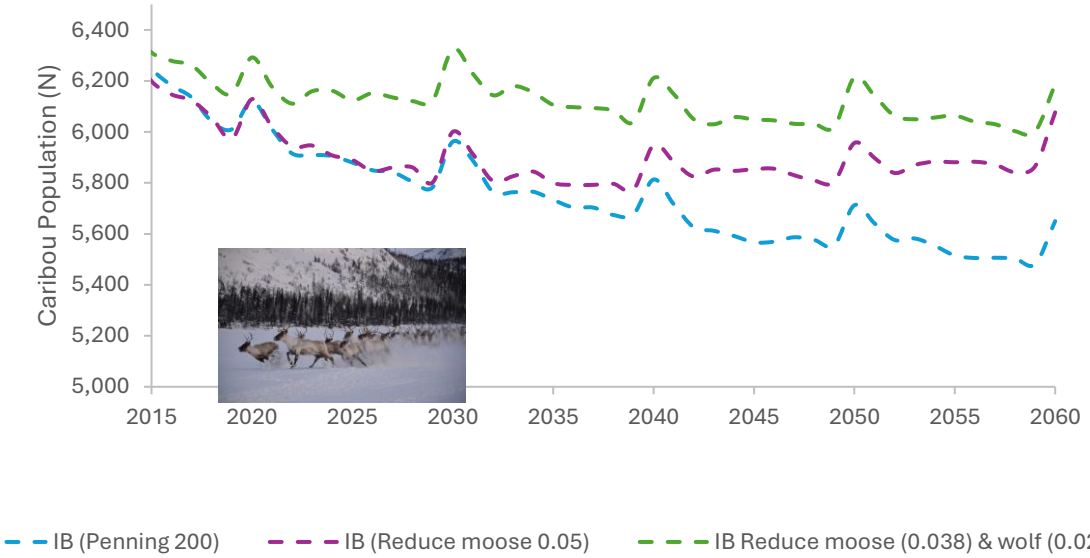


Key Findings

- Climate change and development can significantly and jointly alter system dynamics
- Ecological effects emerge over **decades**, not individual project timelines
- Proactive management actions can meaningfully influence long-term outcomes
- Sustaining balance requires consideration of the full three-species system







Exploring Mitigation Strategies

The modelling framework moves beyond single-project impact assessment to evaluate the full portfolio of management actions that can sustain long-term ecological balance.

Traditional Question

"What is the impact of one project on on caribou habitat?"

This framing misses cumulative interactions, system feedbacks, and the compounding effects of multiple simultaneous stressors.

Systems Question

"Which combination of actions best supports long-term ecological sustainability?"

- Conservation area design and connectivity
- Road and access management strategies
- Habitat restoration and disturbance limits
- Predator-prey management options
- Alternative development footprint scenarios

Kesagami: Applying the Approach

A current Caribou Conservation and Stewardship Program project, led by **John Turn** of the Moose Cree First Nation, is applying similar population dynamics tools within the Kesagami Caribou Range — integrating Indigenous knowledge with quantitative ecological modelling.

Telemetry & Habitat Modelling

Existing caribou GPS collar data and landscape-level habitat models provide the ecological foundation for the Kesagami analysis.

Indigenous Knowledge & Guardian Monitoring

Traditional ecological knowledge and on-the-ground Guardian observations (including camera traps) are integrated directly into the modelling and assessment process.

Climate & Disturbance Scenarios

Future climate projections and landscape disturbance analyses are combined to evaluate conservation options (including sub-range delineation) and inform collaborative decision-making.

Key Messages

A Systems Perspective Is Essential

Maintaining a balanced moose-wolf-caribou system requires requires understanding ecological feedbacks — not evaluating evaluating species or projects in isolation.

Stressors Interact

Development and climate change compound each other's effects other's effects in complex, non-linear ways that only integrated integrated modelling can reveal.

Scale Matters

Regional assessments require broad spatial extents, long planning planning horizons of 60+ years, and integrated ecological modelling frameworks.

Models Support Adaptive Management

Population dynamics models help planners explore future scenarios, evaluate mitigation options, and inform collaborative collaborative conservation decisions with evidence.

Together, these tools provide new perspectives for sustaining ecological integrity across the Ring of Fire region — supporting both supporting both conservation outcomes and Indigenous stewardship priorities.

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Discussion

We invite reflection on how cumulative effects assessment in the Ring of Fire region can be strengthened strengthened through collaboration, science, and Indigenous partnerships.

Indigenous Knowledge

How can Traditional Ecological Knowledge and Guardian monitoring be more meaningfully incorporated into cumulative effects assessment frameworks?

Long-Term Change

How do we design assessments that adequately capture slow-moving ecological shifts unfolding over unfolding over decades rather than project timelines?

Climate Uncertainty

How should regional planning account for the deep uncertainty in climate projections while still while still providing actionable guidance?

Regional Planning

What governance and institutional mechanisms best support integrated, landscape-scale conservation planning across multiple jurisdictions?

Thank you. Questions and discussion are welcome.