Forest Operations Resilience : Adapting practices to mitigate wildfire risk on the landscape

CWF Fall Meeting

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Wildfire Risk and Cost

- Recent years have seen an increase in extreme wildfire events, upward trends in annual area burned and a growing number of large fires, with climate projections predicting events of this magnitude to continue and worsen (Hanes et al. 2025, Kirchmeier-Young et al. 2025)
- Direct cost of wildfires can be $500 million to +$1 billion, with only a fraction going towards preventative measures
- Indirect costs from fires can reach billions annually with short, medium, and long-term effects
- Forest industry impacted by operational shutdowns, damage to equipment and timber, loss of AAC, loss of silvicultural investments … and more

Record-breaking wildfire season in 2023 cost Quebec more than $8B, new study finds

Province's 2023 wildfire season was the worst in over 100 years, with 4.3 million hectares burned



Annabelle Olivier, Sharon Yonan-Renold · CBC News ·
Posted: Aug 20, 2025 4:16 PM ADT | Last Updated: August 22, 2025

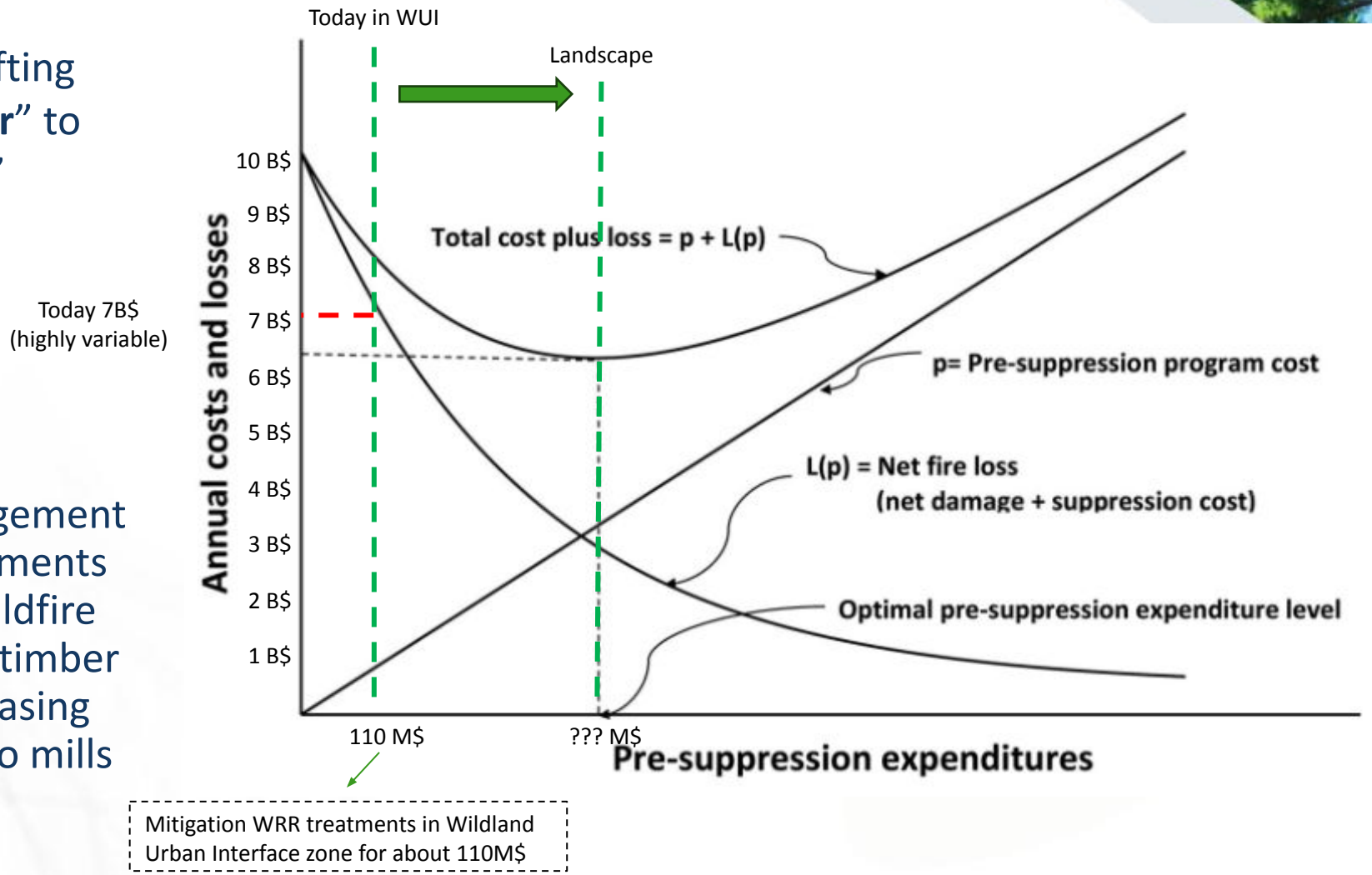
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Finding the Right Balance

As policy approaches are shifting from “**Response and Recover**” to “**Prevention and Mitigation**”

How could forest operations participate?

- Strategic forest management and silviculture investments to reduce potential wildfire intensity, and protect timber resources, while increasing timber supply closer to mills



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Research Vertical

Avoided losses → enable reinvestment in management → further reduces wildfire risk

Wildfire risk and resilience

Operational planning & treatments

- Treatment effectiveness & required maintenance
- Landscape planning (Zoning)
- Rotation period (area %/yr)

Avoided costs and losses

Reinforce resilience and adaptive capacity

- GDP disruptions
- Silvicultural investments
- AAC & wood quality
- Social acceptance

Forest Operations Resilience

Adapted forest management to reduce wildfire risk

Wood supply cost

Economic efficiency & investment capacity

- Roadside fibre cost
- Transport distance
- Biomass integration

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Research Vertical

Wood supply cost



Treatment cost and effectiveness

- Literature review
- Productivity trials
- Slash progression

Wildfire risk and resilience



Spatial modeling

- Quantifying wildfire risk at the landscape scale
- What is the extent of treatment required to lower risk?

Avoided costs and losses



Cost-Benefit

- Quantify costs of implementation and direct/indirect benefits of reduced risk
- Identify barriers and opportunities

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Treatment Cost and Effectiveness

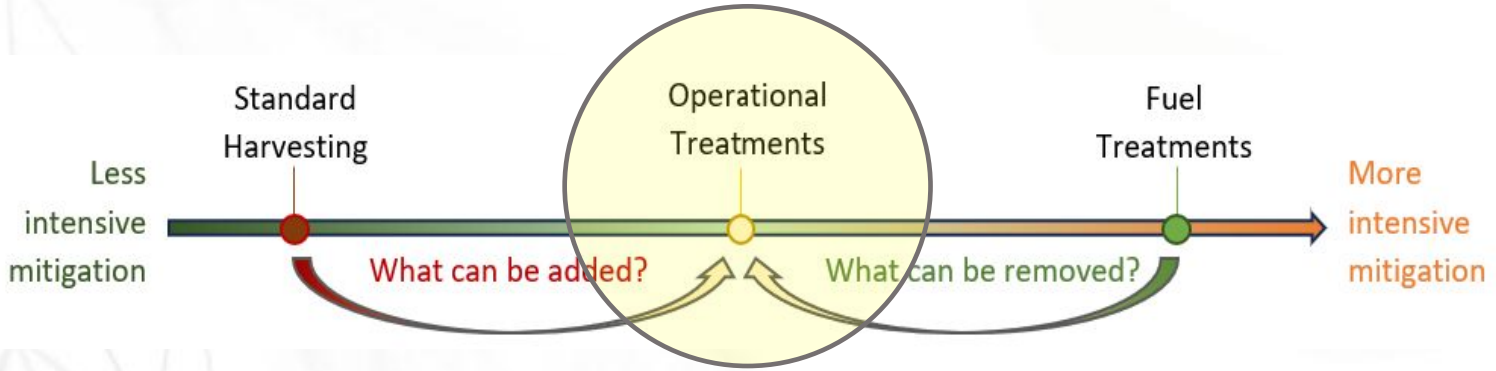
TREATMENT EFFECTIVENESS

Traditional fuel treatments tend to be:

- prioritized around communities
- costly to implement
- time-consuming to plan and complete
- focused on wildfire risk reduction (WRR) without valorization of fibre recovery
- unrealistic for operational forestry

Goal of this phase is to:

- better understand current harvest operations and their influence on WRR
- investigate potential alterations in practices that reduce wildfire risk and enhance fibre recovery
- suggest effective operational shifts



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PRODUCTIVITY TRIALS

Outcomes:

- Harvester productivity increases with pulp & rat tail added but decreases with biomass
- Stand type influences productivity
- Biomass recovery reduces fuel loading
- Productivity in clearcuts well established and fuel loading through BiOS modeling plus slash progression

Trial #1



Trial #2



Trial #3





Trial #4

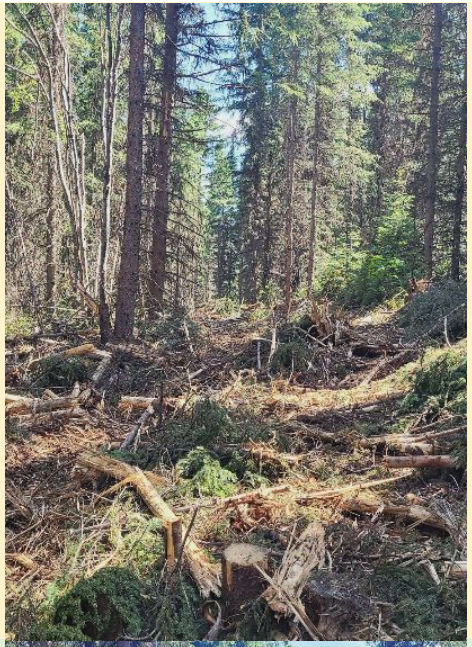


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TRIAL #1
Blue Ridge, Alberta

TRIAL #4
Prince George, BC

TRIAL #6
Forêt Montmorency, QC





SAWLOG ONLY

What is the difference in fire behaviour?

WITH BIOMASS RECOVERY

d.

Slash Progression

Measured fuel loads in a chronosequence of clearcut and commercially thinned blocks.

Selected blocks in similar geographic areas, fuel types, and harvest systems/seasons.

- **Clearcut (CC) sites**
  - Burns Lake, BC – 3 blocks
  - Swan Hills, AB – 3 blocks
  - Slave Lake, AB – 3 blocks
  - Chibougamau/Lebel-sur-Quevillon/Amos, QC – 8 blocks
- **Commercial thinning (CT) sites**
  - Saguenay-Lac-Saint-Jean/Baie-Comeau, QC – 10 blocks



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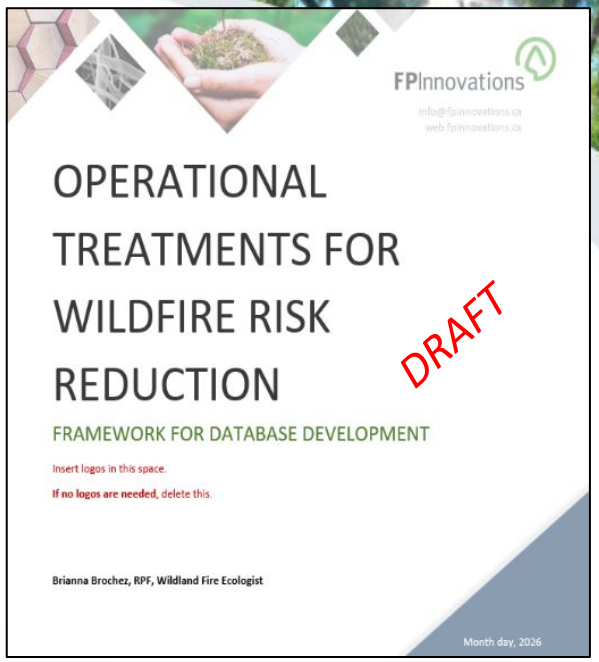
OPERATIONAL TREATMENTS TRIALS

Data collected:

- Assess cost/productivity, fuel load metrics and fire behaviour in treated areas
- Assess how treatments change over time and impacts to fire behaviour in regenerating stands

Outcomes of data collection:

- Inform treatment assignment by stand
- Improved fire behaviour for spatial modeling
- Foundational data for cost/benefit assessment





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Spatial Modeling

Wildfire Risk – Defined

- Wildfire Risk is quantified by determining the *intensity* and *probability* of a potential fire, along with the v*ulnerability* of the landscape to loss of *value* from that fire
    - Intensity – measure of the energy generated through the passage of a wildfire (kW/m). Product of fuel consumption (kg/m^2) and rate of spread (ROS; m/min)
    - Probability – likelihood of fire occurrence and spread. Modeled based on historical fire starts, weather, and fuel availability. Can be conditional (i.e., specific weather) or averaged from multiple stochastic iterations.
    - Vulnerability – susceptibility to potential impacts and ability to recover from said impacts. Can be assessed quantitatively (e.g., $ value) or qualitatively (e.g., ecological function)
- *Other common measures:*

    Hazard – the potential for fire to occur. Can be described using a single attribute (e.g., fuel availability) or combined attributes (e.g., intensity x probability).

    Severity – the impact of a fire (i.e., fuel consumption, depth of burn, scorch height, stem mortality, etc.)

    Exposure – spatial interaction of potential fire and an asset of value



adapted from Scott et al. 2013

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Measuring Risk

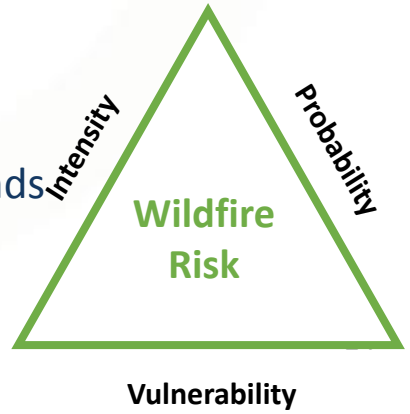
- *Exposure Metric*
- *Fuels Management Analyst Plus (FMAPlus)*
- *Canadian Fire Effects Model (CanFIRE)*
- *Crown Fire Initiation Spread (CFIS)*
- *FuelCalcBC*
- *Canadian Conifer Pyrometrics (CCP)*
- *FARSITE*
- *Fire and Fuels Extension Forest Vegetation Simulator (FFE-FVS)*
- *Burn P3*

We investigated many common wildfire models utilized in Canada and the US and found:

- Current disconnect between landscape-level fire probability and spread models (e.g.,BurnP3+, FlamMap) and stand-level fire effects models (e.g., CanFIRE, CFIS) with no one model providing all 3 sides of the Risk triangle
  - Landscape-level tools utilize generalized fuel data (FBP fuel types) along with fire history, weather, and topography to model fire spread and probability without allowing for stand-level structure or modification to be considered
  - Stand-level tools utilize high resolution fuel data input and weather to model fire intensity and effects but not landscape level burn probability
- Many tools are developed for usage in continental US, not including boreal species

Development of a combined tool utilizing **BurnP3+** for fire probability and **CanFIRE** for stand-level intensity and fire effects. This tool will allow for modified harvest prescriptions to be reflected in fire behavior at the stand and landscape level

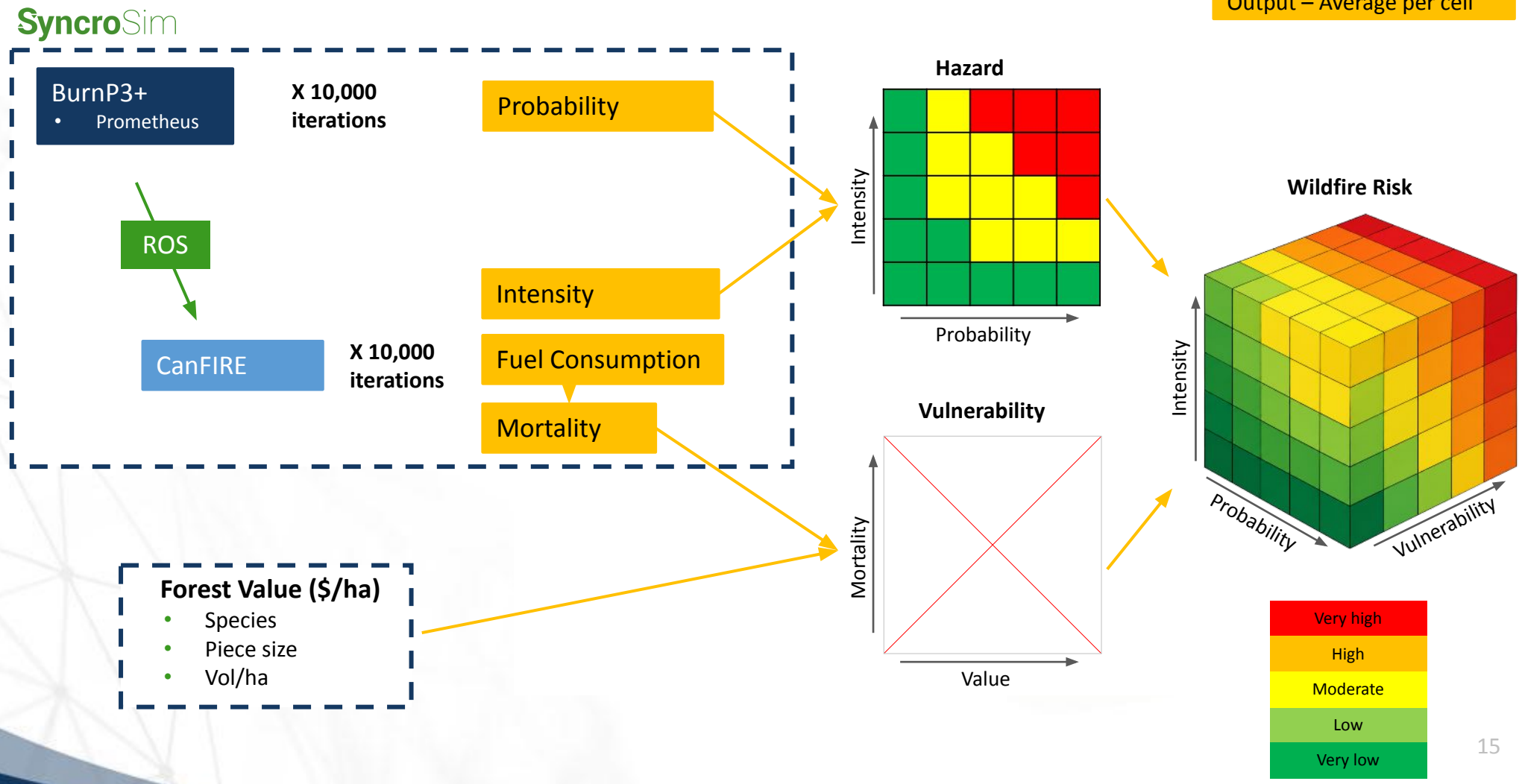
- Tool is being developed with ApexRMS within the SyncroSim that currently houses BurnP3+
- Additional expansion of CanFIRE functionality based on field trials and literature review to improve results in combined fuel types and modified stands



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Custom Model Development

- Fire weather
- Fire Regime
- Slope
- FBP fuel types (from inventory)
- Stand level by species
  - QMD
  - Height
  - Density
- Operational treatments
- Harvest exclusion areas



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Pilot Project and Outcomes

- **Can the wildfire risk be quantified at the landscape level AND can it be reduced with forest management?**
  - Model development Q1-Q2
  - Pilot Study completed through Q3-Q4 to determine Go/No-Go results from model
    - GO – meaningful reduction of Risk at the landscape level with a *realistic* level of harvest
    - NO-GO – No reduction achieved or unfeasible level of harvest required (i.e., +5% annually)

- **Out of scope (for now):**
  - Operational costs and specific feasibility constraints, however harvest levels must be *realistic* - i.e., harvesting levels must be below ~2.5-5% overall (20 - 40-year rotation) but the true feasibility constraints will be determined in cost-benefit exercise
  - Optimization - Significantly complicates model function; potential for future development or integration with existing optimization programs
  - Climate change scenarios - Key part of WRR in the long-term; opportunity for further work in this area once the baseline has been established

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Cost Benefit

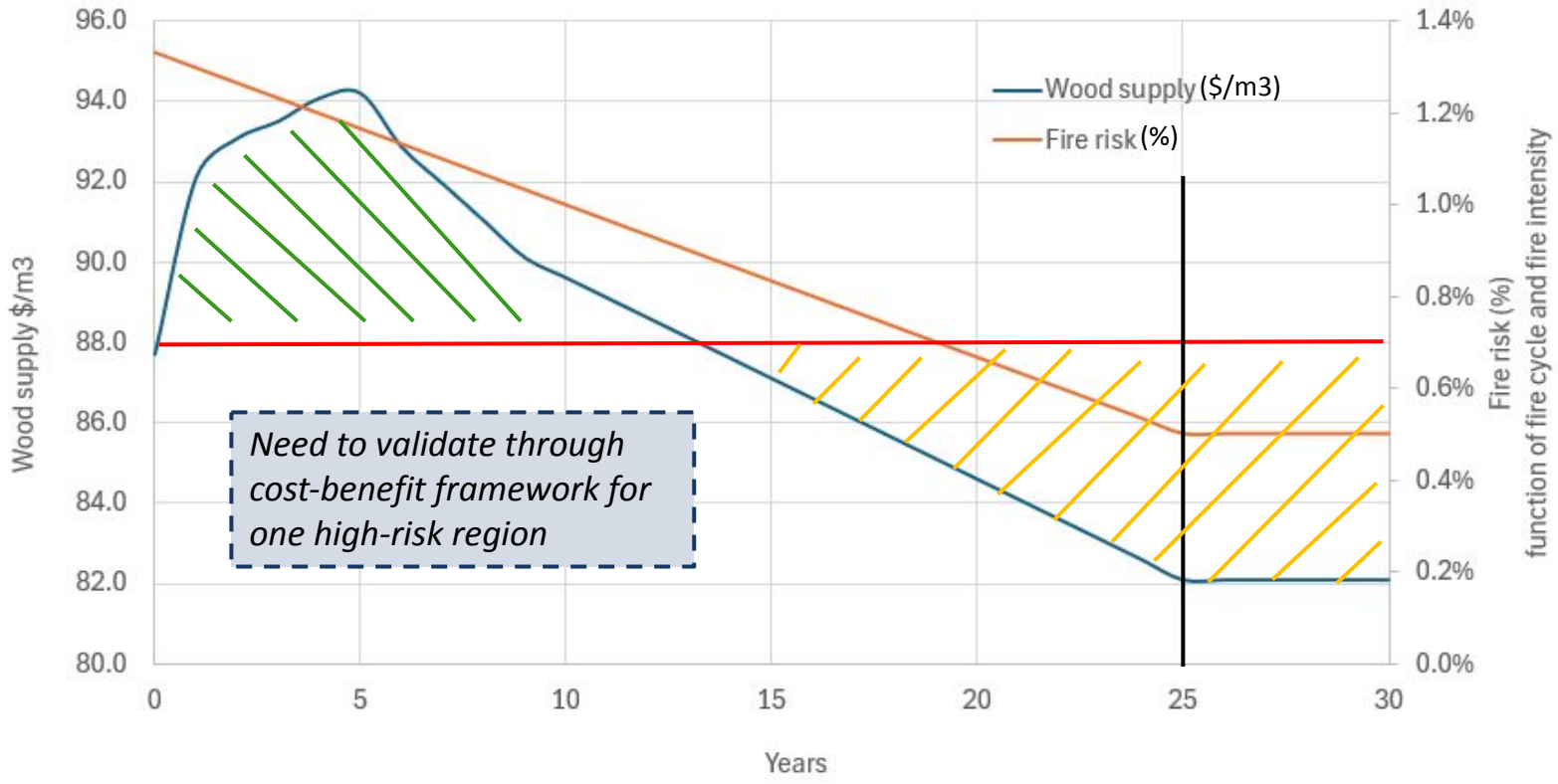
TECHNO-ECONOMICS

COSTS

- ✔ Harvesting productivity loss – operating in smaller diameter stands (↑ $/m^3)
- ✔ Deploying integrated operations with biomass recovery (↑ $/m^3)
- ✔ Roads - less m^3 harvested / km of road built (↑ $/m^3)
- ✔ Sawmills - Smaller logs at the mill (↑ $/m^3 value difference)

BENEFITS

- ✔ Protect timber resource and lower wildfire risks around critical infrastructures (reduce potential damages) (↓ $/m^3)
- ✔ Minimize disruptions to supply chain (↑ weeks of ops)
- ✔ Increase wood supply closer to mills and lower avg. transport distances by 15-20% (↓ $/m^3)



Red line *- harvest cost baseline without inflation*
Green area *- added cost through treatment*
Yellow area *- reduced cost through reduced risk*
Black line *- Payback time*
Projected savings in 30 years

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Cost-Benefit Analysis

- **Mapping of economic zone**
  - Map extent of the intensive zone & required intensity of treatments (ha/yr)
- **Timescale feasibility**
  - Identify time-period to realize risk reduction
- **Wood supply impacts**
  - AAC, transport distance, biomass availability, sawmill diet …

OUTCOME
Regional evaluation framework - tested with pilot region.
Costs – Second Go/No-Go

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Thank you

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