Fuel for Thought:
How Fuel Treatments Tame the Flames

UBC Forestry

Centre for Wildfire Coexistence
University of British Columbia

Dr. Lori Daniels, Tessa Black, Matthew Broder, Fiona Landwehr, Caleb Loewen, Issac Lowenthal Walsh, Daniel Skinner, Mike Stefanuk

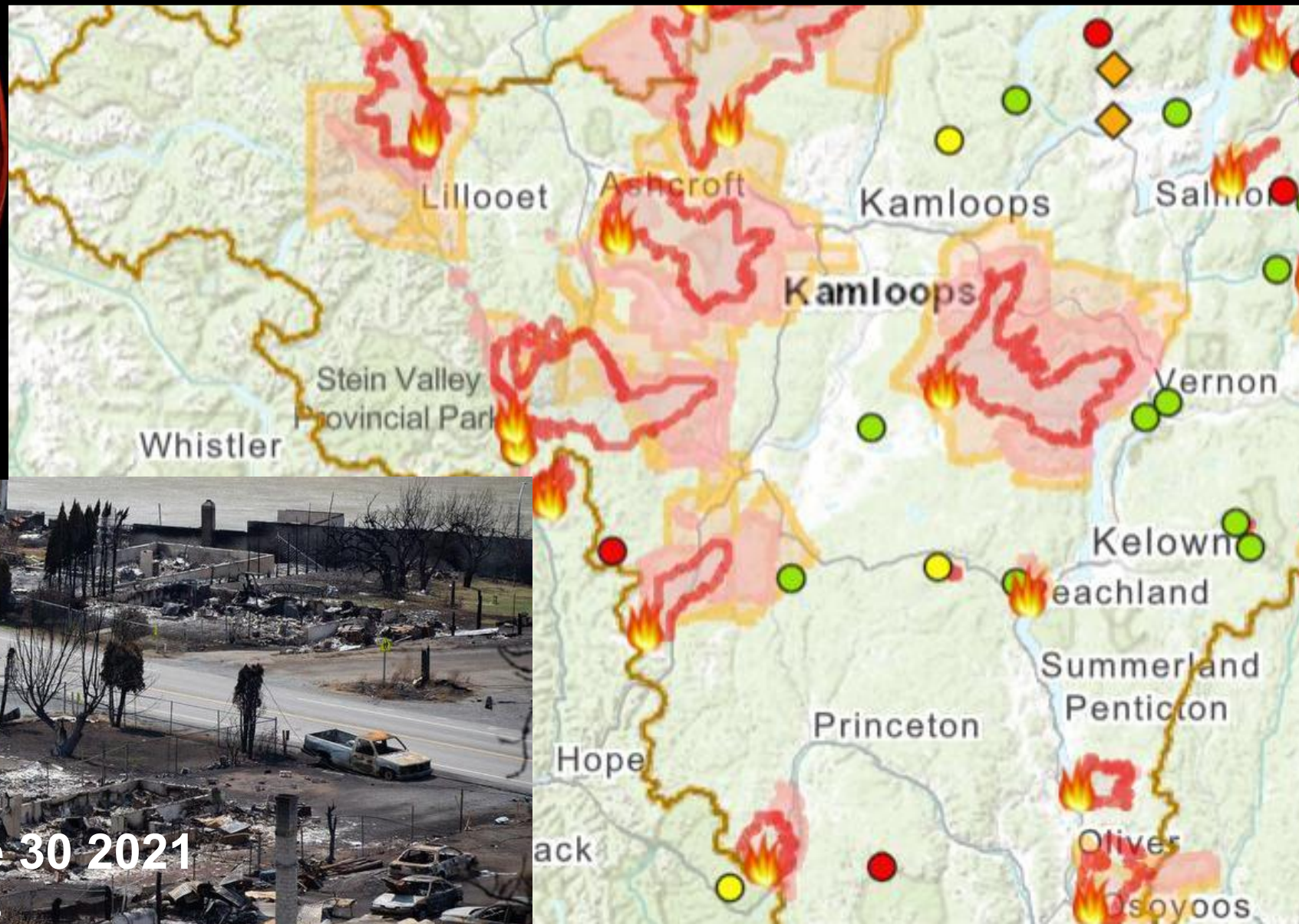
UBC is on the Ancestral Lands of the xʷməθkʷəy̓əm sḵwx̱wú7mesh & səlilwətaɬ

Cheakamus Community Forest
December 3, 2024

2021 Heat Dome & Wildfires in BC

1 in 1000-year event, 150x less likely without climate change

Philip et al. 2021, Earth System Dynamics

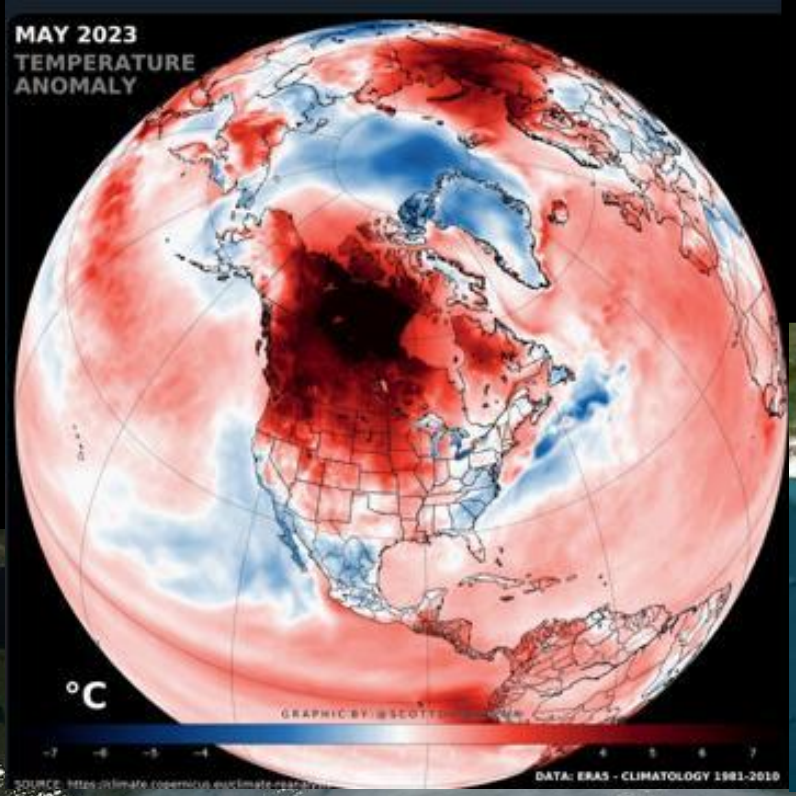


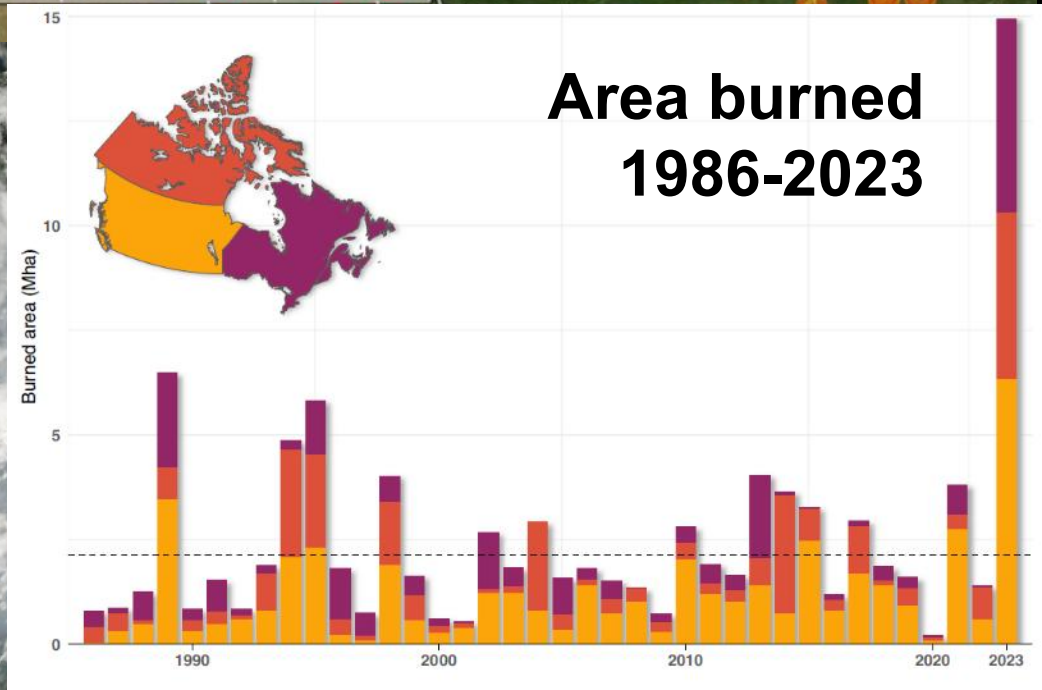
90% of Lytton burned, June 30 2021

Photo: Darryl Dyck, Canadian Press

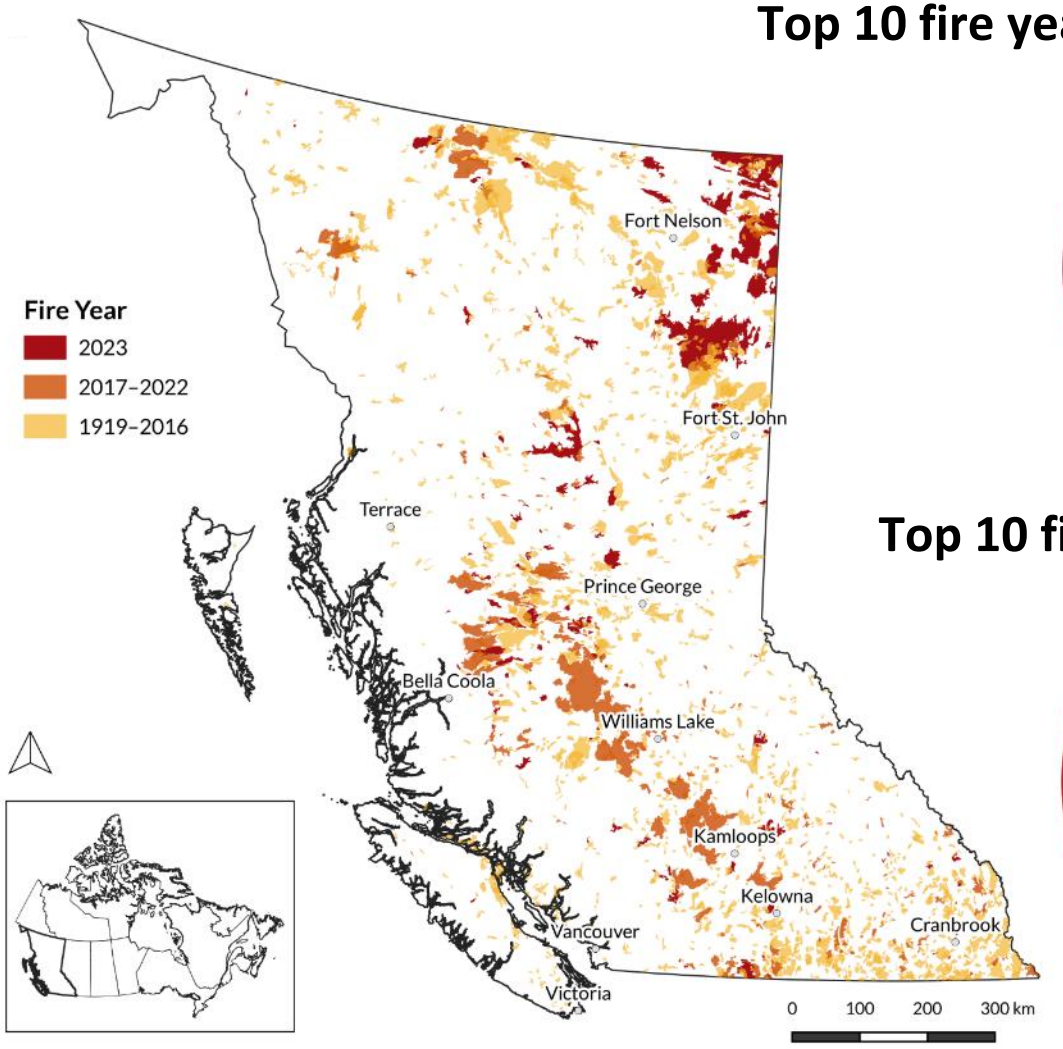
2023 Wildfires in Canada

15M ha burned, releasing 410 MT of C

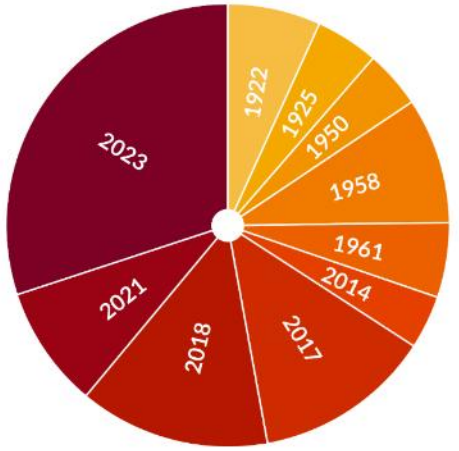




Wildfires in BC 1919 -2023



Top 10 fire years:



Top 10 fires:

Parisien et al. 2023 *Nature Communications Earth & Environment*
Daniels et al. 2024 *Canadian Journal of Forest Research*

“Wildfire Behaviour Triangle”

fire type, intensity, rate of spread, severity, effects

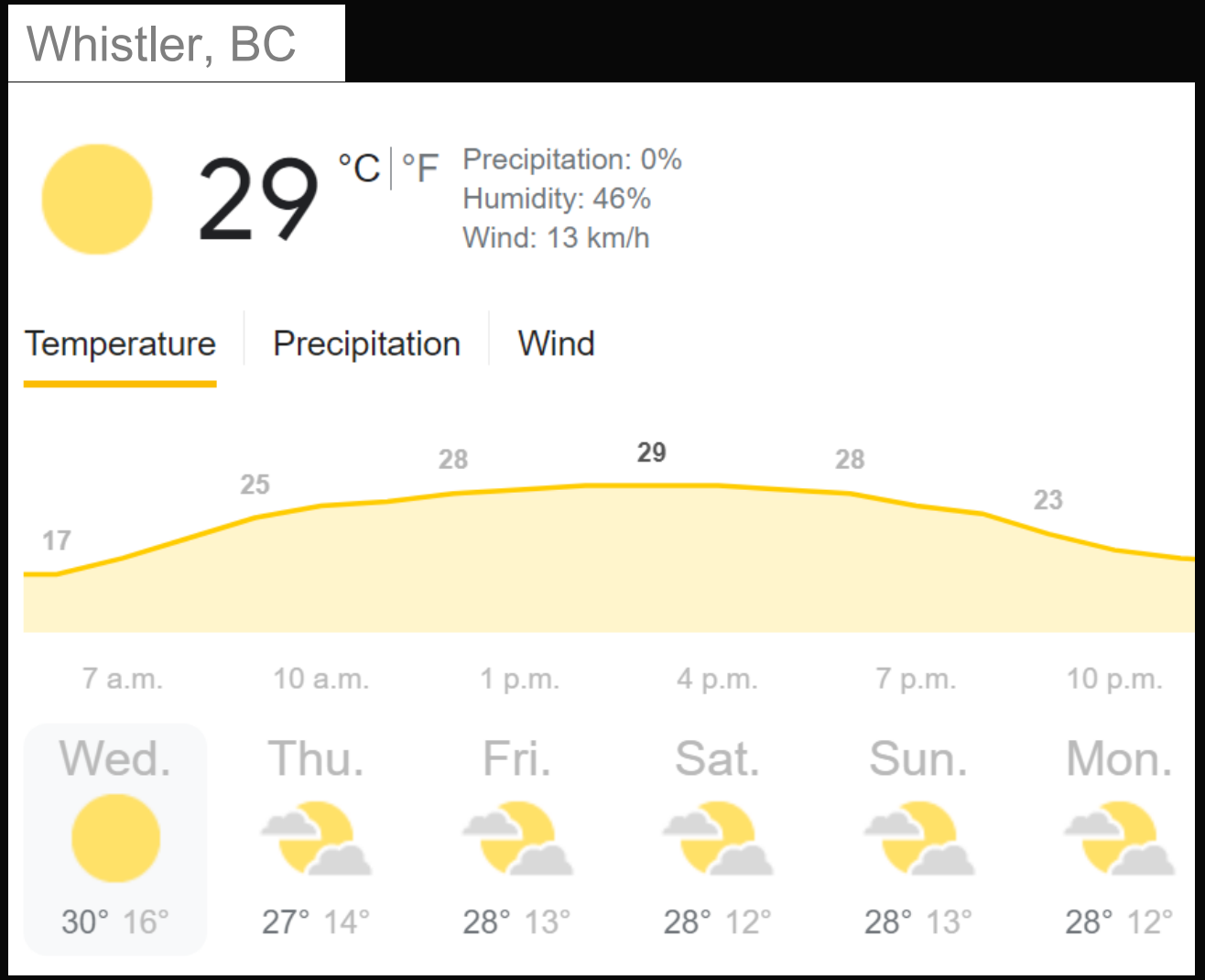
“Wildfire Behaviour Triangle”

Topography includes elevation, steepness + aspect of slopes.

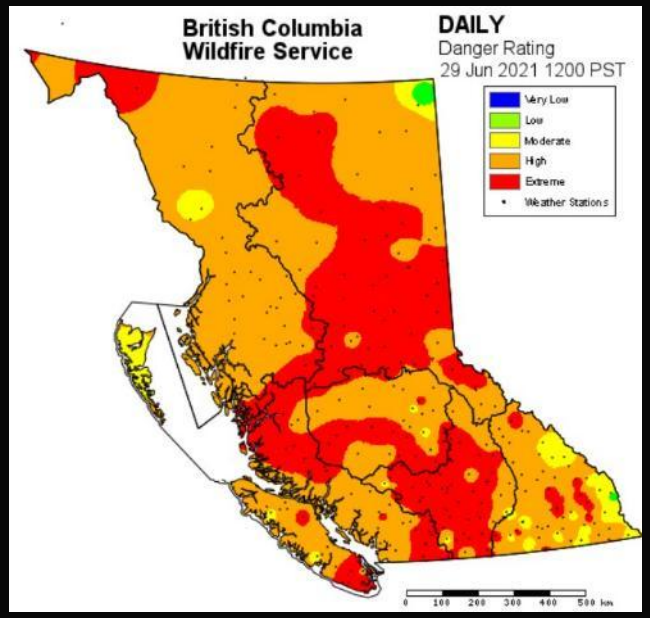
Of the three axes, topography is most stable in space and time.

“Wildfire Behaviour Triangle”

Weather varies continually, influencing fire danger



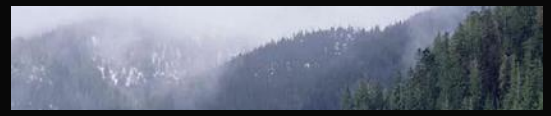
The Weather Channel



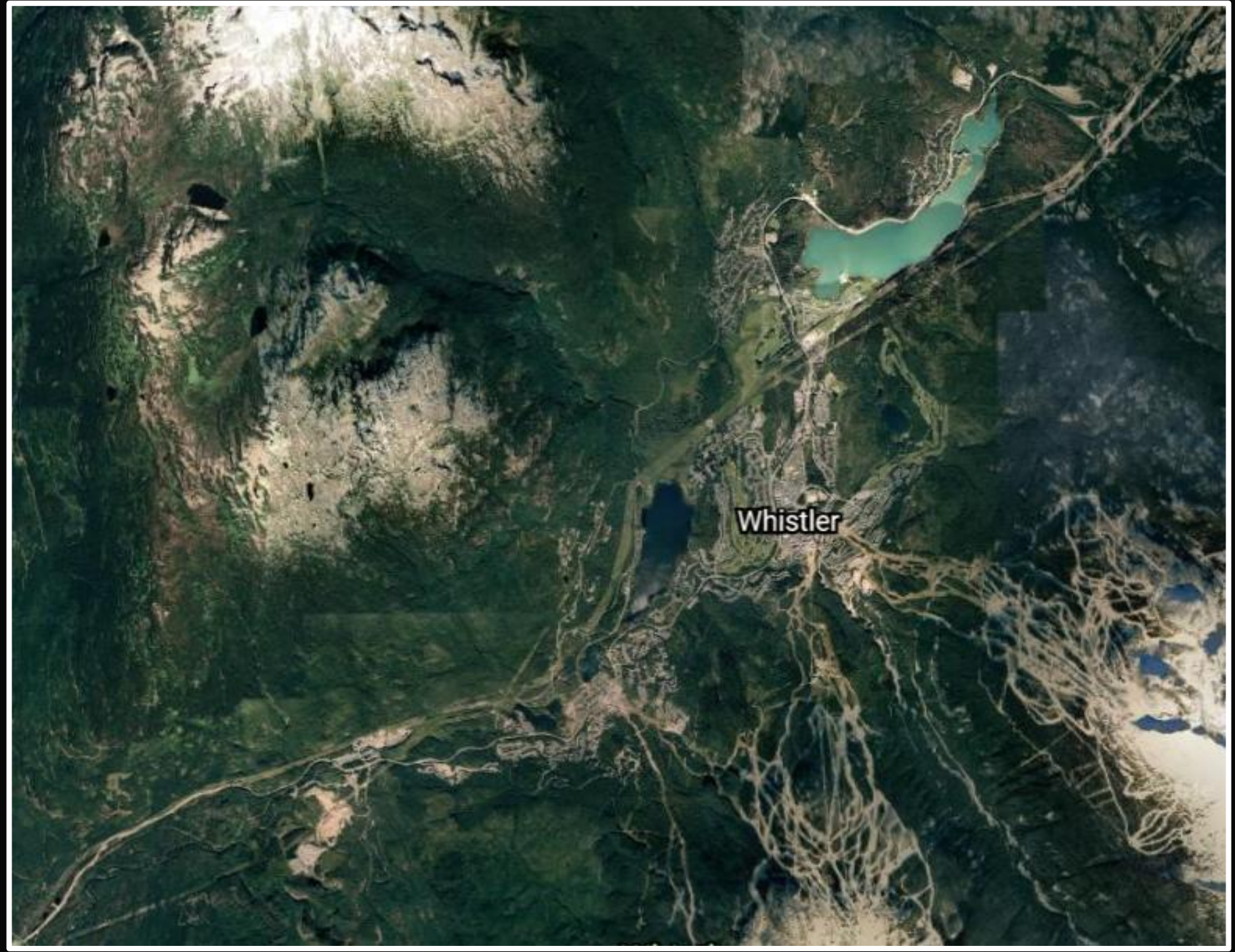
BC Wildfire Service

“Wildfire Behaviour Triangle”

Fuels vary among forests and change through time as trees grow and forests change after disturbance



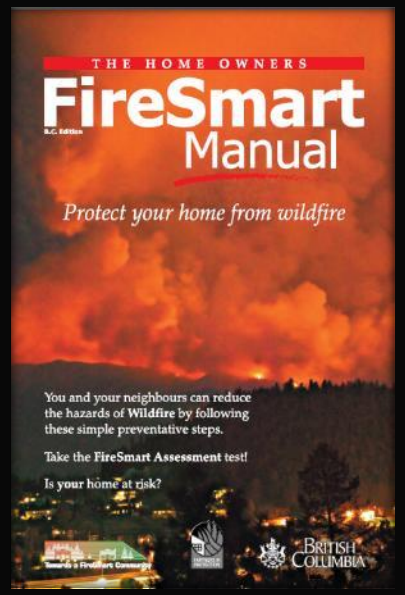
Of the three axes, we have the greatest control over fuels.

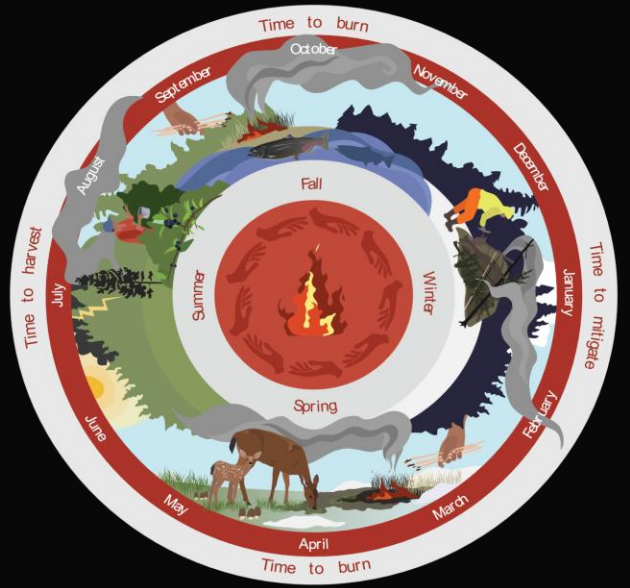

Whistler

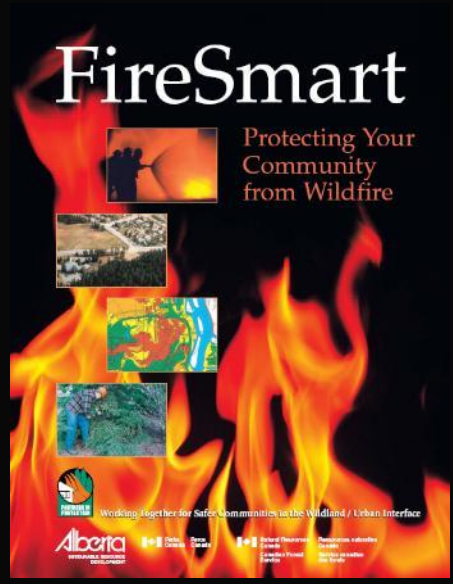

Boulder Creek Fire
Elaho Fire

Control plots
Treatment plots
Whistler

Proactive Fuel Treatments: Mitigate Fire Risk



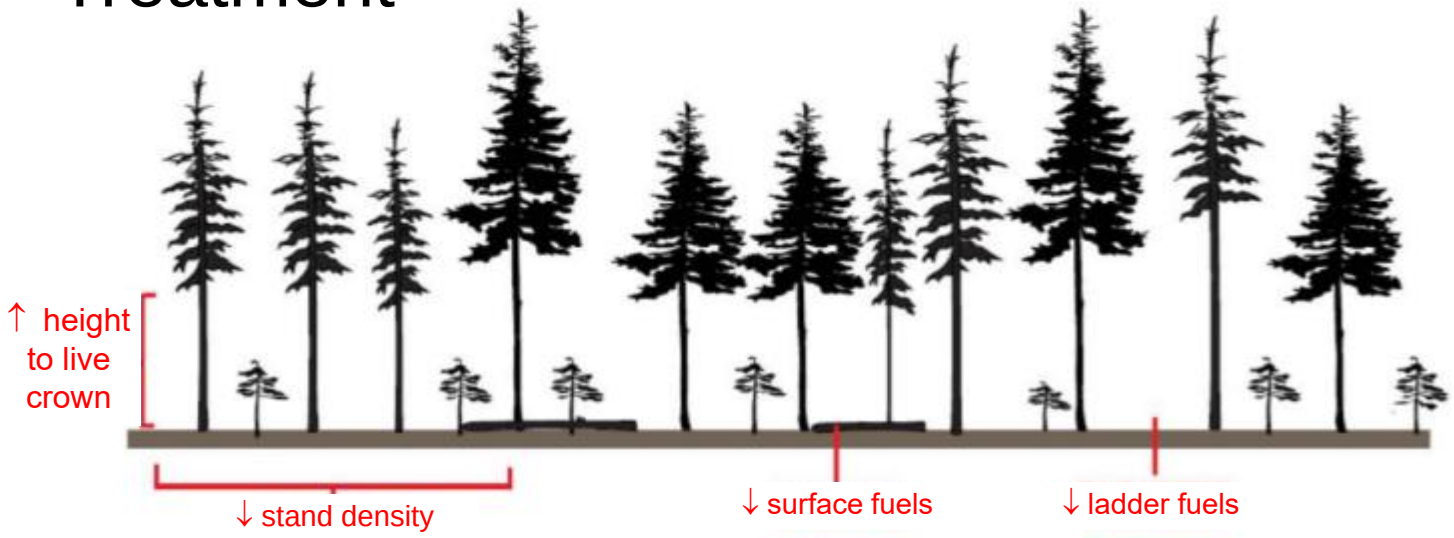




Proactive Fuel Treatments: Mitigate Fire Risk

No Treatment

Treatment



Treatment goals:

↓ surface fire intensity
↓ active crown fire
↑ fire resilience

Fuels mitigation:

↓ tree density
↓ surface fuels
↑ height to live crown

Assessing efficacy:

Field measures +
Fire behaviour models

Assessing Treatments: Fire Behaviour Modelling

Topography
- location
- elevation
- slope aspect
- slope angle

Weather
- 90th percentile
- 29.6 °C
- 24% RH
- 13.1 kph winds

Fuels
- tree diameter, height, branch height
- forest cover and density
- calculate canopy fuel abundance
- surface wood and ground fuels

Fire Behaviour Prediction System
- surface fuel consumption

Crown Fire Initiation and Spread
- probability of crown fire
- type of fire (crown *v* surface)

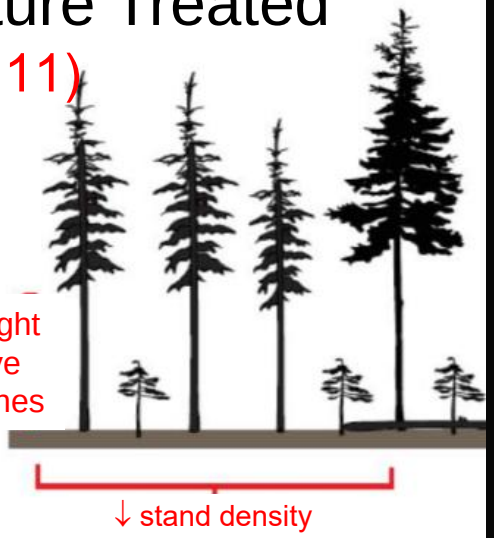
Daniels *et al.* 2023

Proactive Treatments Mitigate Fuel Loads

Young Untreated
(n = 7)

Tree cover	90 %
Tree density	1243 per ha
Branch height	3.7 m
Canopy fuel	0.33 kg/m^2
Surface fuel	1.8 kg/m^2

Mature Treated
(n = 11)



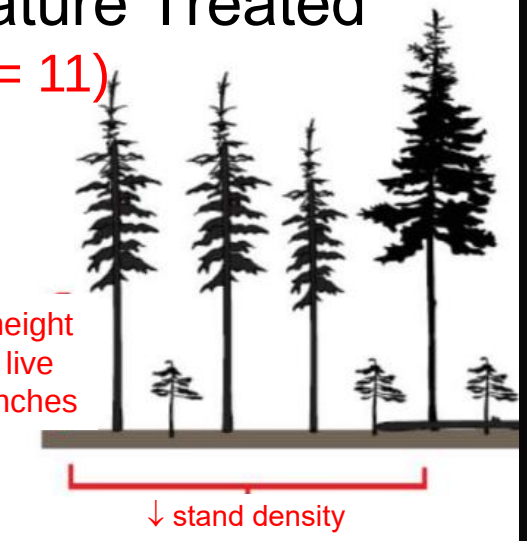
Tree cover	82 %
Tree density	564 per ha
Branch height	8.2 m
Canopy fuel	0.15 kg/m^2
Surface fuel	1.6 kg/m^2

Bold = statistically different ($\alpha = 0.05$)

Proactive Treatments Reduce Predicted Fire Behaviour

Young Untreated
(n = 7)

Mature Treated
(n = 11)

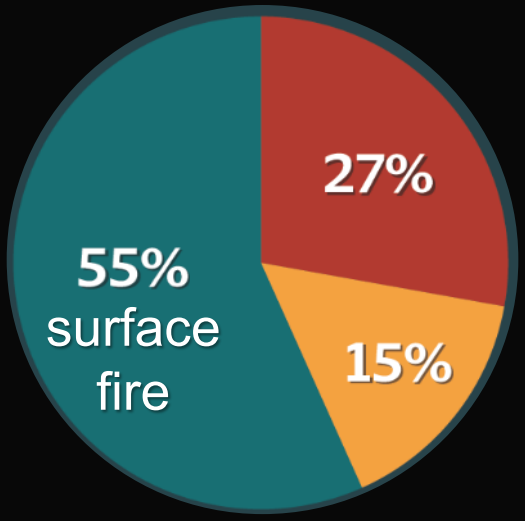


Probability
(crown fire > 50%)

87 ± 6%

40 ± 10%

Fire type



Proactive Treatments Emulate Forest Development

Mature Untreated
(n = 5)

Tree cover	67 %
Tree density	540 per ha
Branch height	5.3 m
Canopy fuel	0.16 kg/m^2
Surface fuel	2.0 kg/m^2

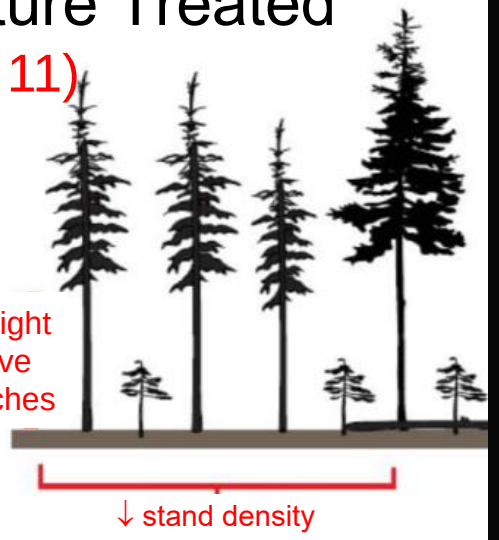
Mature Treated
(n = 11)

Tree cover	82 %
Tree density	564 per ha
Branch height	8.2 m
Canopy fuel	0.15 kg/m^2
Surface fuel	1.6 kg/m^2

Proactive Treatments Reduce Predicted Fire Behaviour

Mature Untreated
(n = 5)

Mature Treated
(n = 11)

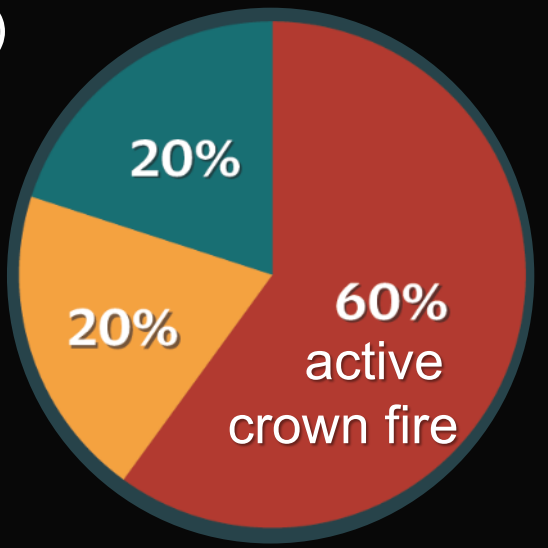


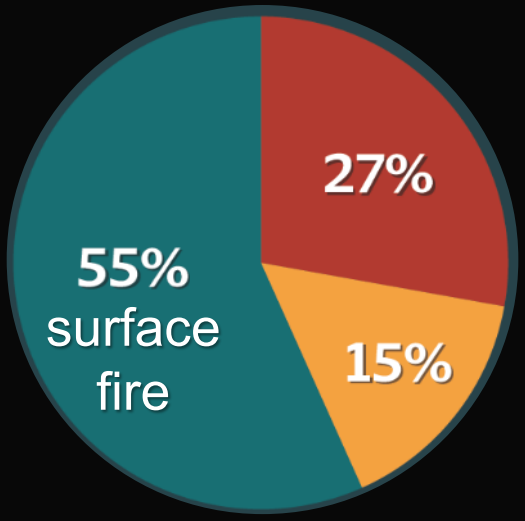
Probability
(crown fire > 50%)

67 ± 19%

40 ± 10%

Fire type





Key Findings

How do fuel treatments tame the flames?

- Treatments transform young dense forests toward mature forests
- Mitigate ladder and crown fuels, reduce chance of crown fire
- Shift predicted fire behaviour from crown to surface fire
- Increase resilience by reducing potential severe crown fire

Take Home Message

Our findings show proactive fuel treatments reduce chance of crown fire by half, increasing forest resilience in the wildland-urban interface in Whistler.

Thanks to our collaborators:

CHEAKAMUS COMMUNITY FOREST
FRONTERA FOREST SOLUTIONS INC.
CHARTWELL
WHISTLER
Resort Municipality of Whistler

FUEL FOR THOUGHT:
How Fuel Treatments Tame The Flames

Lori Daniels, Tessa Black, Matthew Broder, Fiona Landwehr, Caleb Loewen, Isaac Lowenthal Walsh, Daniel Skinner & Mike Stefanuk
Centre for Wildfire Coexistence, Faculty of Forestry, University of British Columbia Vancouver

INTRODUCTION

QUESTIONS

- **In the wildland-urban interface of Whistler, how do proactive treatments alter forest fuels and fire risk?**
- **What are proactive treatments?**
  - Remove subcanopy and some canopy trees
  - Prune lower branches of retained trees
  - Chip or pile and burn surface fuels

RESEARCH METHODS

FIELD METHODS

- Field data plots (n = 23)
- Topography measurements:
  - Location, elevation, slope angle, aspect
- Fuel measurements:
  - All trees diameter >7.5 cm
  - Canopy cover
  - Surface wood and ground fuels
- Weather inputs to model:
  - 90th percentile weather for August: 29.6°C, 24 % RH, 13.1 km/h wind speed

COMPARISON OF FOREST FUELS

- Classified fuel types based on forest structure
- Statistically compared key attributes

PREDICTIVE MODELLING

- Canadian Fire Behaviour Prediction System
- Crown Fire Initiation and Spread model

FOREST TYPE	FUEL LOADS	PREDICTED FIRE TYPE

Young Untreated Forest (n = 7)

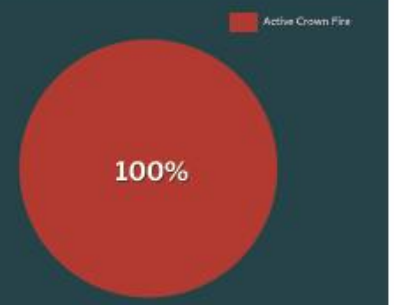
Tree cover = 90 ± 7%

Density = 1243 ± 350 trees/ha

Height to branches = 3.7 ± 1.8 m

Surface wood = 1.8 ± 0.5 kg/m²

Probability of crown fire = 87 ± 6%



Mature Untreated Forest (n = 5)

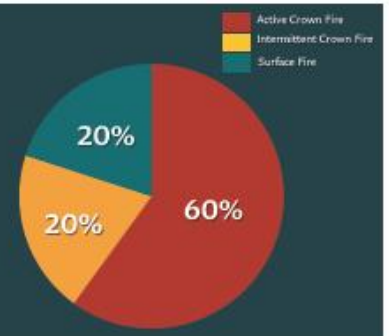
Tree cover = 67 ± 22%

Density = 540 ± 207 (trees/ha)

Height to branches = 5.3 ± 4.4 (m)

Surface wood = 2.0 ± 0.6 (kg/m²)

Probability of crown fire = 67 ± 19%



Mature Treated Forest (n = 11)

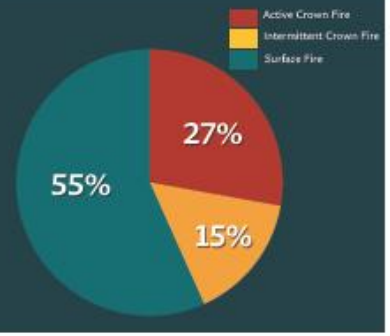
Tree cover = 82 ± 11%

Density = 564 ± 242 trees/ha

Height to branches = 8.2 ± 3.2 m

Surface wood = 1.6 ± 0.5 kg/m²

Probability of crown fire = 40 ± 10%



KEY FINDINGS

HOW DO FUEL TREATMENTS TAME THE FLAMES?

Thinning treatments transform young dense forests to resemble mature forests and shift predicted fire behaviour from active crown fire to surface fire

- **Young untreated forests...**
  - Are dense with short trees and low branches
  - Have abundant ladder and canopy fuels and the highest prediction of active crown fire (100%)
- **Mature treated forests...**
  - Have low tree density, tall trees, and high branches, with fewer canopy fuels
  - Have the lowest prediction of active crown fire (27%) and highest chance of surface fire (55%)
- **Proactive fuel treatments...**
  - Emulate and accelerate forest development from young to mature structures
  - Mitigate fuel loads and shift predicted fire behaviour from crown to surface fire
  - Increase forest resilience by reducing potential for severe crown fires in future

TAKE HOME MESSAGE

Our findings show proactive fuel treatments reduce chance of crown fire by half, increasing forest resilience in the wildland urban interface of Whistler.

Thank you to our collaborators:

THE UNIVERSITY OF BRITISH COLUMBIA
Faculty of Forestry

CHEAKAMUS COMMUNITY FOREST · FRONTERA · CHARTWELL · Centre for Wildfire Coexistence

WHISTLER | Resort Municipality of Whistler