Understanding landscape-level resilience to fire in British Columbia's Okanagan

Jocelyne Laflamme, Paul Hessburg, Brion Salter, Susan Prichard, Bob Gray

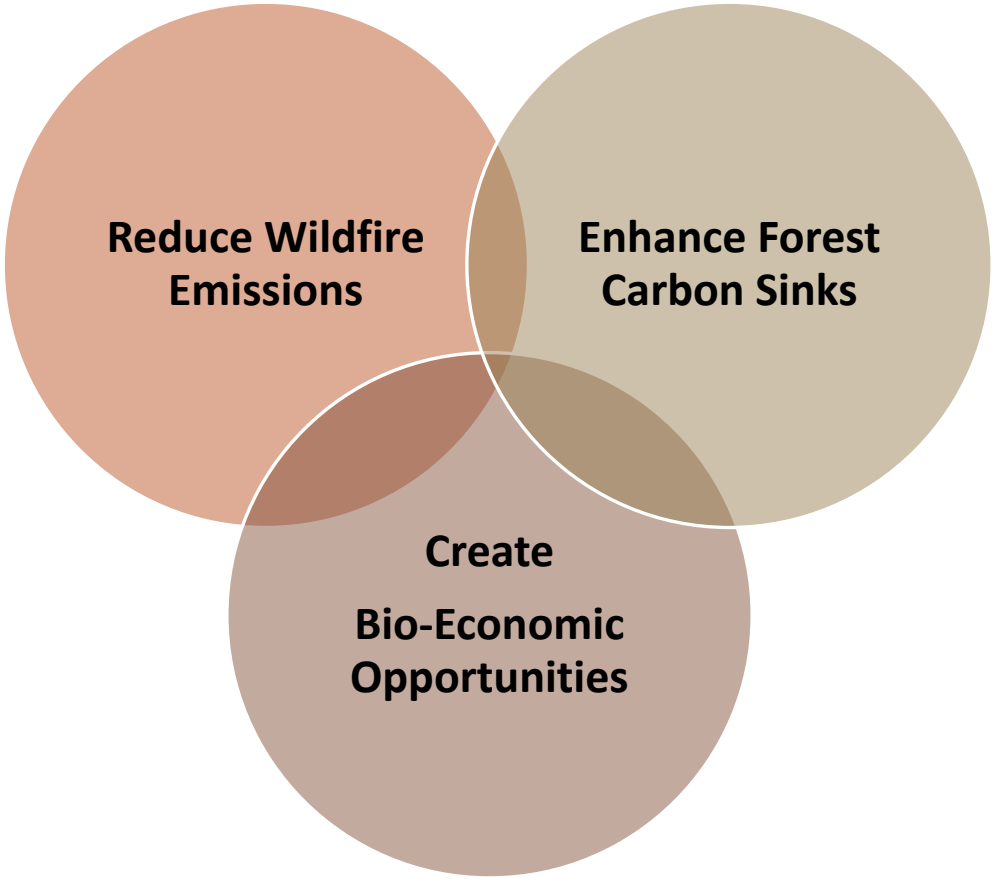
jocelyne.laflamme@ubc.ca

- Historically, cultural burning and natural fire regimes created landscape level resilience
- Accumulation and continuity of fuels after 100 years of fire suppression make them vulnerable to severe fire behavior
- Fuel treatments proven to help at the stand-level, but landscape level impacts remain poorly understood

WILDFIRE & CARBON PROJECT

- Funded by the Pacific Institute for Climate Solutions
- Collaboration between UBC, CFS, and USFS

Can management actions lead to resilient landscapes, and reduce emissions from wildfires that are greater than the emissions from the actions themselves?



RESEARCH OBJECTIVES: UNDERSTANDING LANDSCAPE RESILIENCE

1) **Historical Landscapes**: what created resilience in the past?

2) **Aspen**: did hardwoods play a role in historical resilience, and could they play a role in the future?

3) **Future Climate**: how will the characteristics that create resilience change under future climates?

4) **Forest Management**: how can we use management tools to create these resilient characteristics?

Understanding landscape resilience requires a model that is capable of:

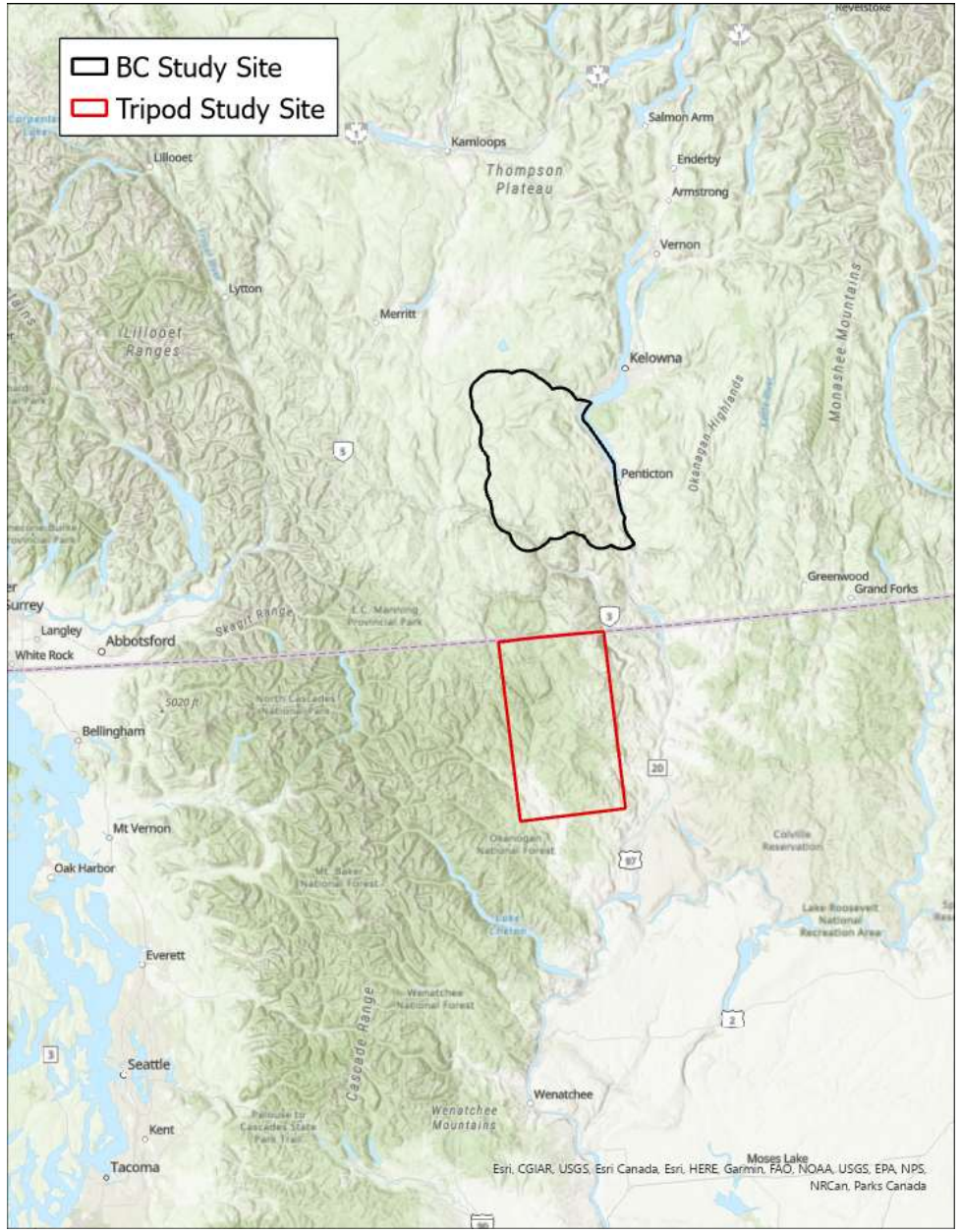
1. Capturing the two-way feedbacks between vegetation and fire
2. Can differentiate between untreated forest and those with different fuel treatments

REBURN

Simulates the feedbacks between wildfire dynamics and forest and fuel succession across the landscape

Composed of two components:

1. State – Transition Models (STMs)
2. Fire Simulation Model



REBURN - STATE AND TRANSITION MODELS

Pathway A: No Fire Succession


State 1A: PFBG, NB9, 0-14 yr


State 2A: SI, TL4, 15-24 yr.


State 3A-4A: SECC, TL4, TL7. 25-59 yr.


State 5A: UR, TL7, 60-119 yr


State 6A: YFMS, TU5, 120-179 yr


State 7A: OFMS, SB3, ≥ 180 yr.

Pathway B: Succession with Low or Moderate Severity Fire


State 1B: SI, TU4, 0-14 yr


State 2B/3B: SI/SEOC, GS1/TL4 15-39 yr


State 4B: SEOC, TU4, 40-59 yr


State 5B: SEOC, TU4, 60-119 yr


State 6B: SEOC, TU4, 120-179 yr


State 7B: OFSS, TU4, 180-219 yr

Pathway C: Succession with High Severity Reburns


State 1C: PFBG, NB9, 0-14 yr


State 2C: SI, GR1, 15-24 yr


State 3C: SEOC, GS1, 25-39 yr


State 4C/5C: UR, TL4/TL7, 49-119 yr


State 6C: YFMS, TU4, 130-179 yr


State 7C: OFMS, TU5, 180-219 yr

STATE AND TRANSITION MODELS

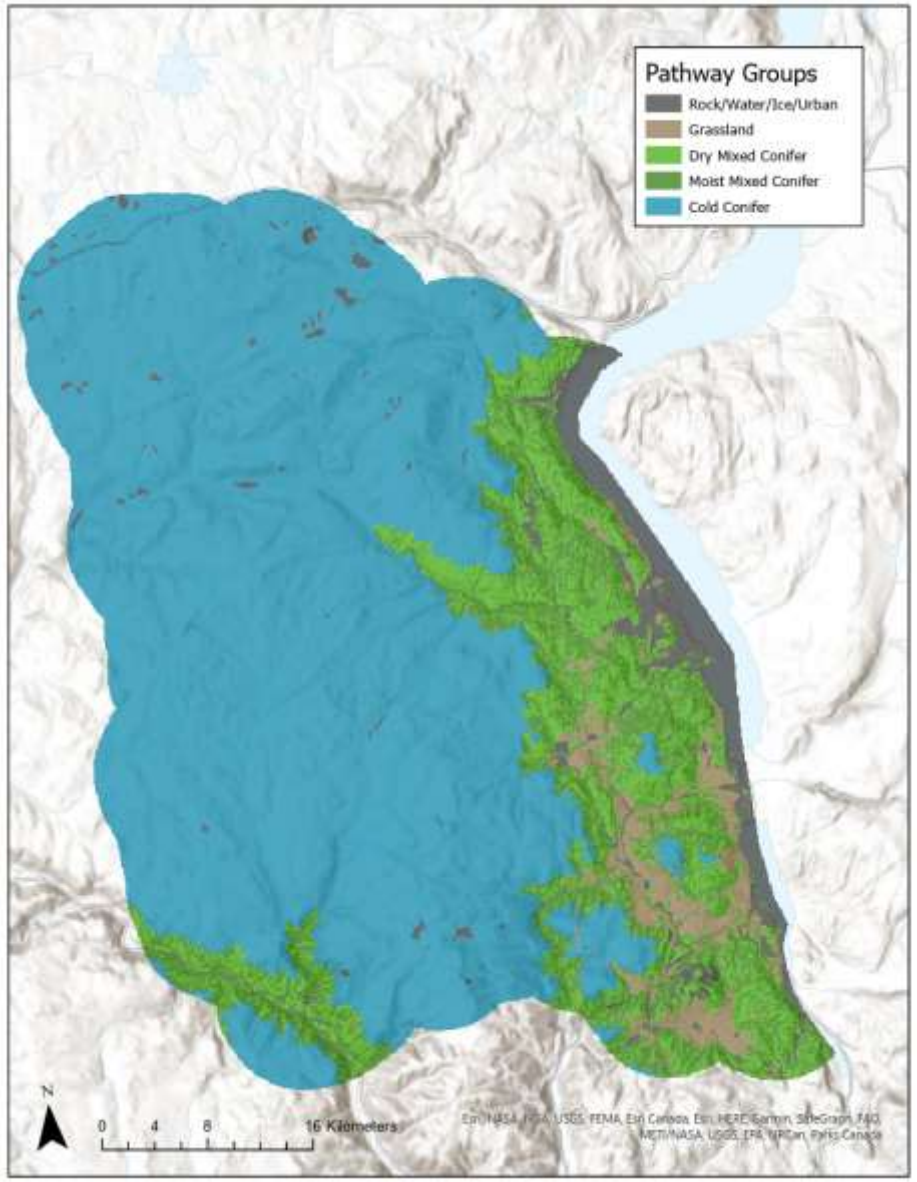
Forest Types / Pathway Groups

1) Dry mixed conifer:
   - Low elevation, Douglas fir and ponderosa pine
   - Low site productivity (south facing aspect, mid slopes and ridge tops)

2) Moist mixed conifer
   - Low elevation, Douglas fir and ponderosa pine
   - High site productivity (north facing aspect, toe slopes and valley bottoms)

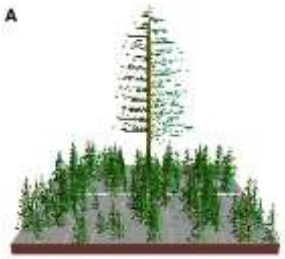
3) Cold conifer
   - High elevation
   - Engelmann spruce, subalpine fir, lodgepole pine

Non-Forest Cover Types:
- Rock/Water/Ice
- Grassland/Shrubland



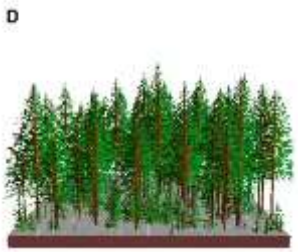
STATE AND TRANSITION MODELS

PFBG = Post-fire Bare Ground



SI = Stand Initiation

SECC= Stem Exclusion Closed Canopy



UR = Understory Re-initiation

YFMS = Young Forest Multistory

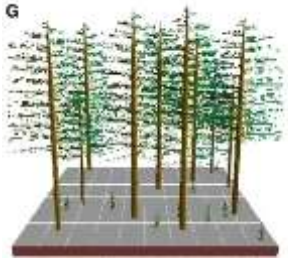
OFMS = Old Forest Multi Story

Fire 'Fences'

SEOC= Stem Exclusion Open Canopy

Altered structure due to low or moderate severity fire events

Also act as fire fences, or at least mitigate fire behaviour



OFSS = Old Forest Single Story

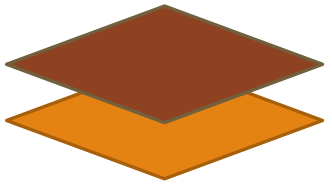
Fuel Parameters:

- Structure class
- Surface fuel model
- Canopy height
- Canopy bulk density
- Canopy base height
- Canopy cover

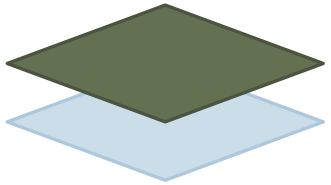
Used to evaluate:

- Fire behaviour
- Timber availability
- Carbon stocks
- Wildlife habitat

REBURN : MODEL WORKFLOW



Raster layers describing surface and canopy fuels



Raster layers describing age and state of each pixel

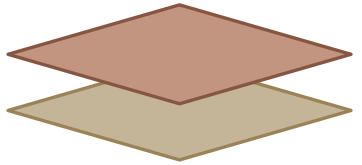
1) State Transition Models

- Grows forest and fuels
- Updates forest conditions after disturbance

2) Fire Simulation Model (FSPro)

- Simulates fire ignitions, spread, and severity across the landscape based on weather, topography and fuels

Raster layers describing fire perimeters and burn severity



RESEARCH OBJECTIVES: UNDERSTANDING LANDSCAPE RESILIENCE

1) **Historical Landscapes**: what created resilience in the past?

2) **Aspen**: did hardwoods play a role in historical resilience, and could they play a role in the future?

3) **Future Climate**: how will the characteristics that create resilience change under future climates?

4) **Forest Management**: how can we use management tools to create these resilient characteristics?

HISTORICAL SCENARIO

Climate Data

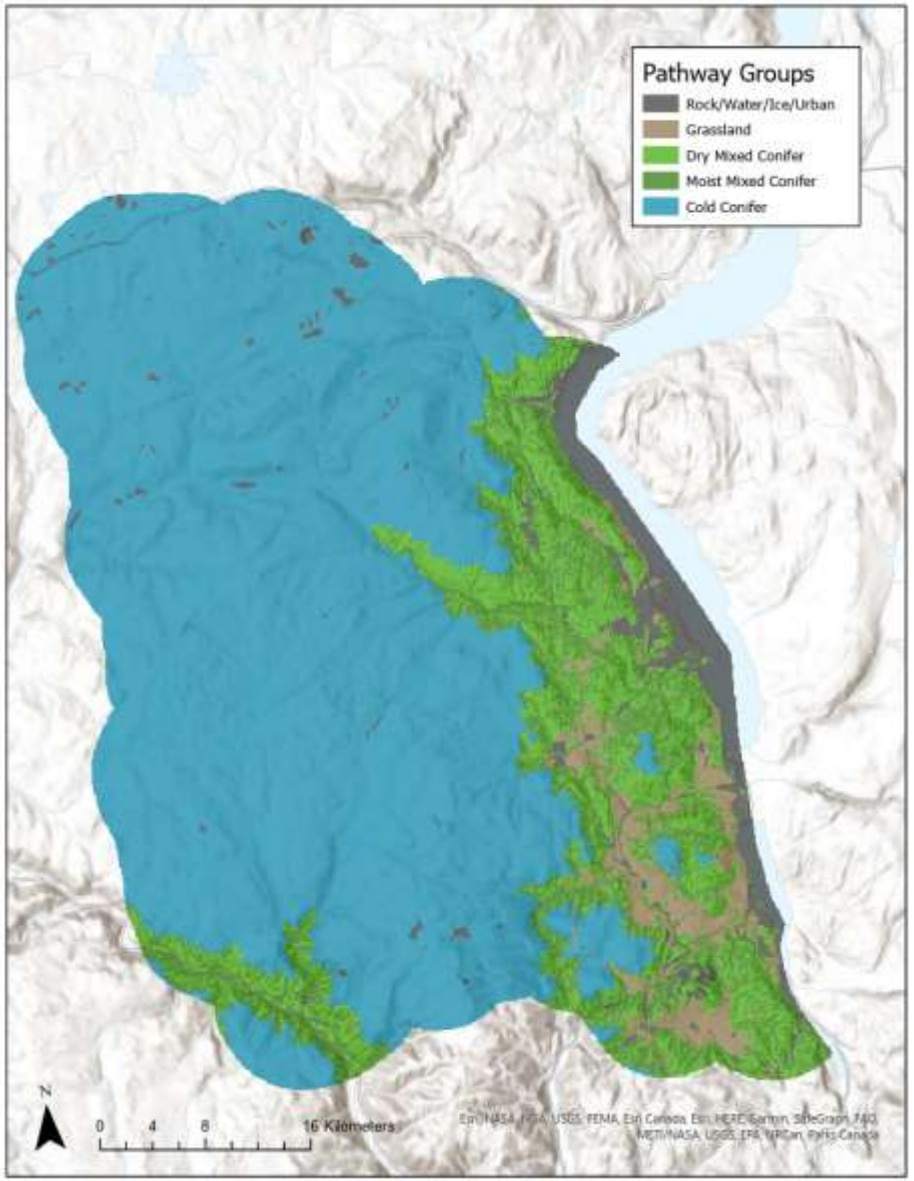
- Used the VIC (variable infiltration capacity) climate dataset
- Included climate from years 1915 - 2011

Forest Map

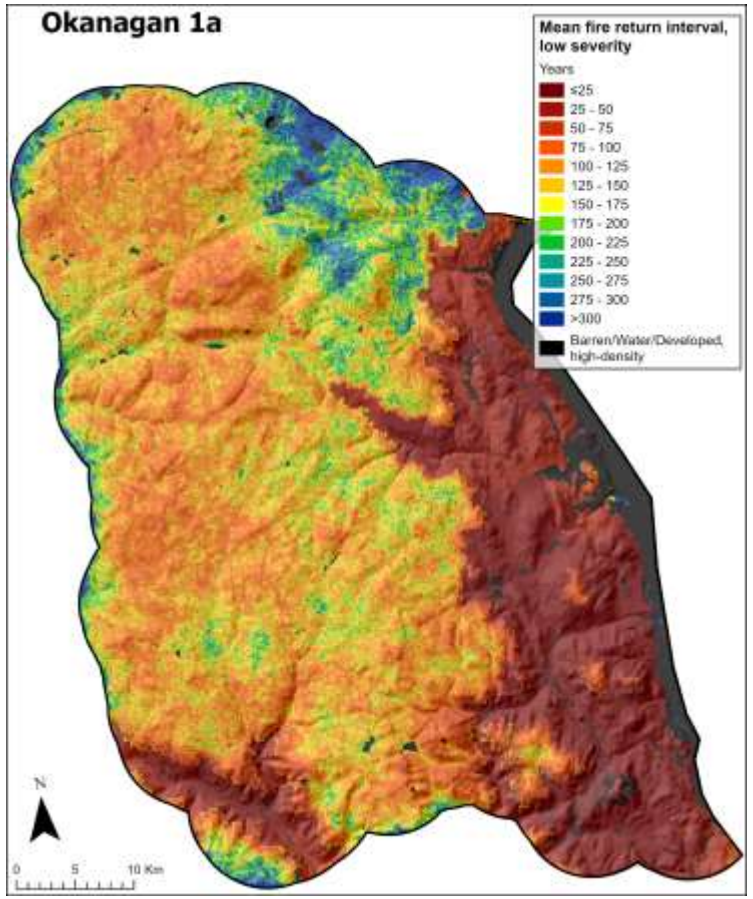
- Used tree feasibility map created by 1961-1990 climate normals

Management

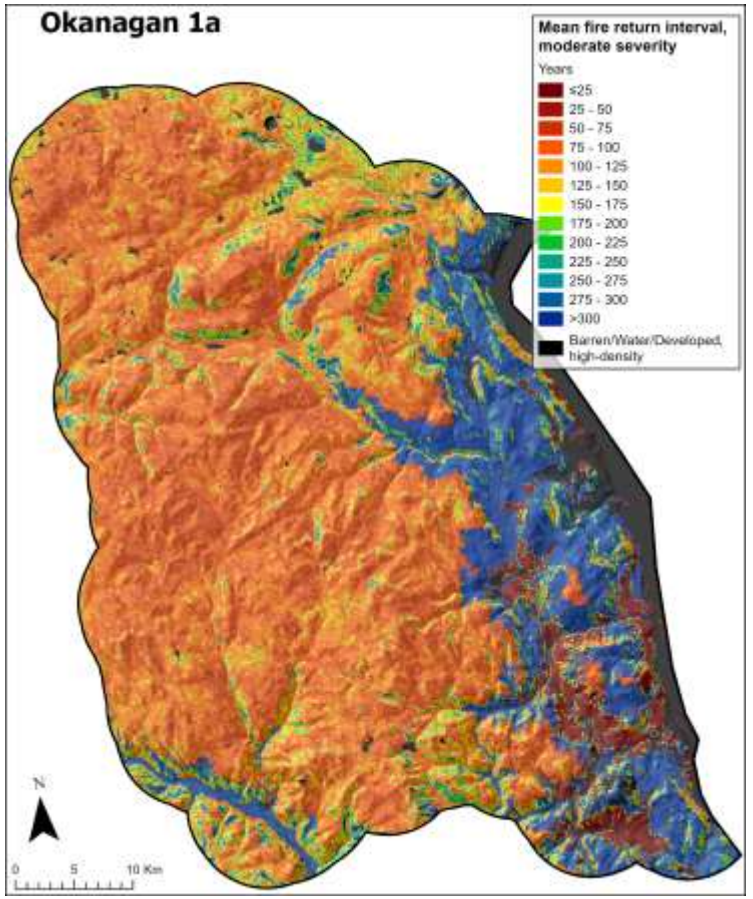
- Did not include forest management or fire suppression



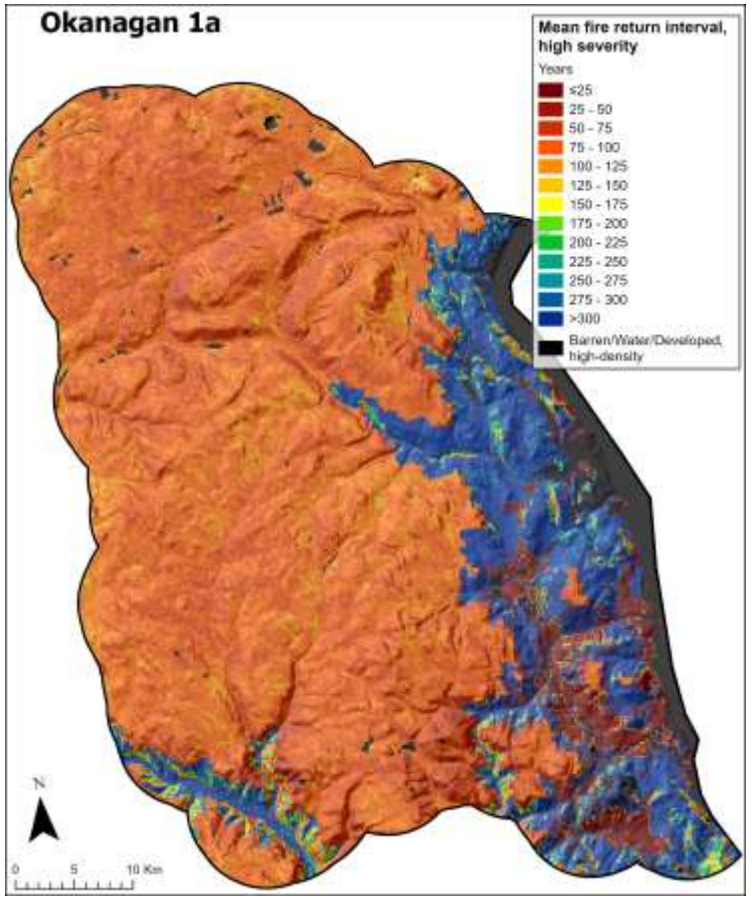
Low Severity Fire Return Interval



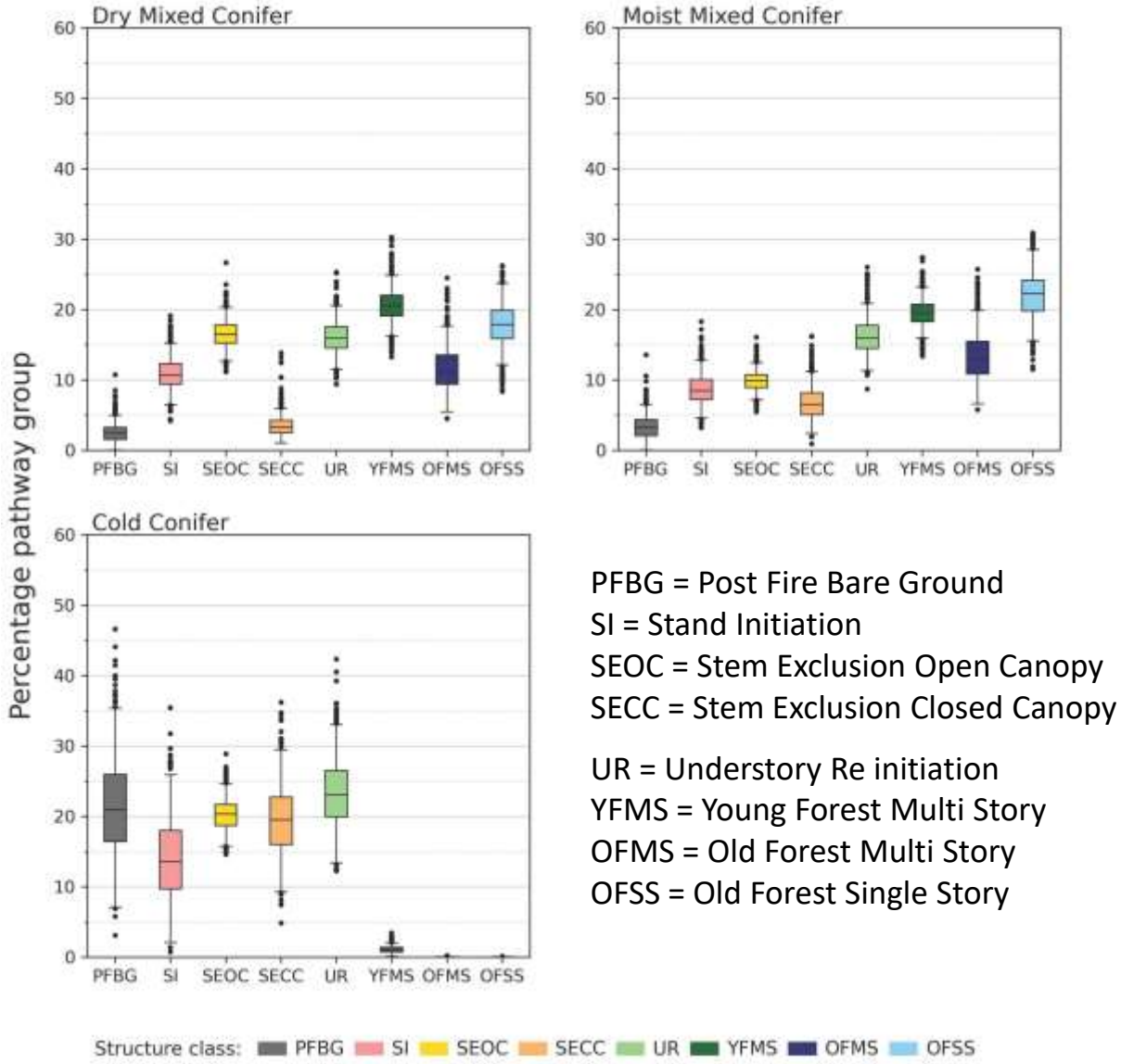
Moderate Severity Fire Return Interval



High Severity Fire Return Interval



HISTORICAL SCENARIO

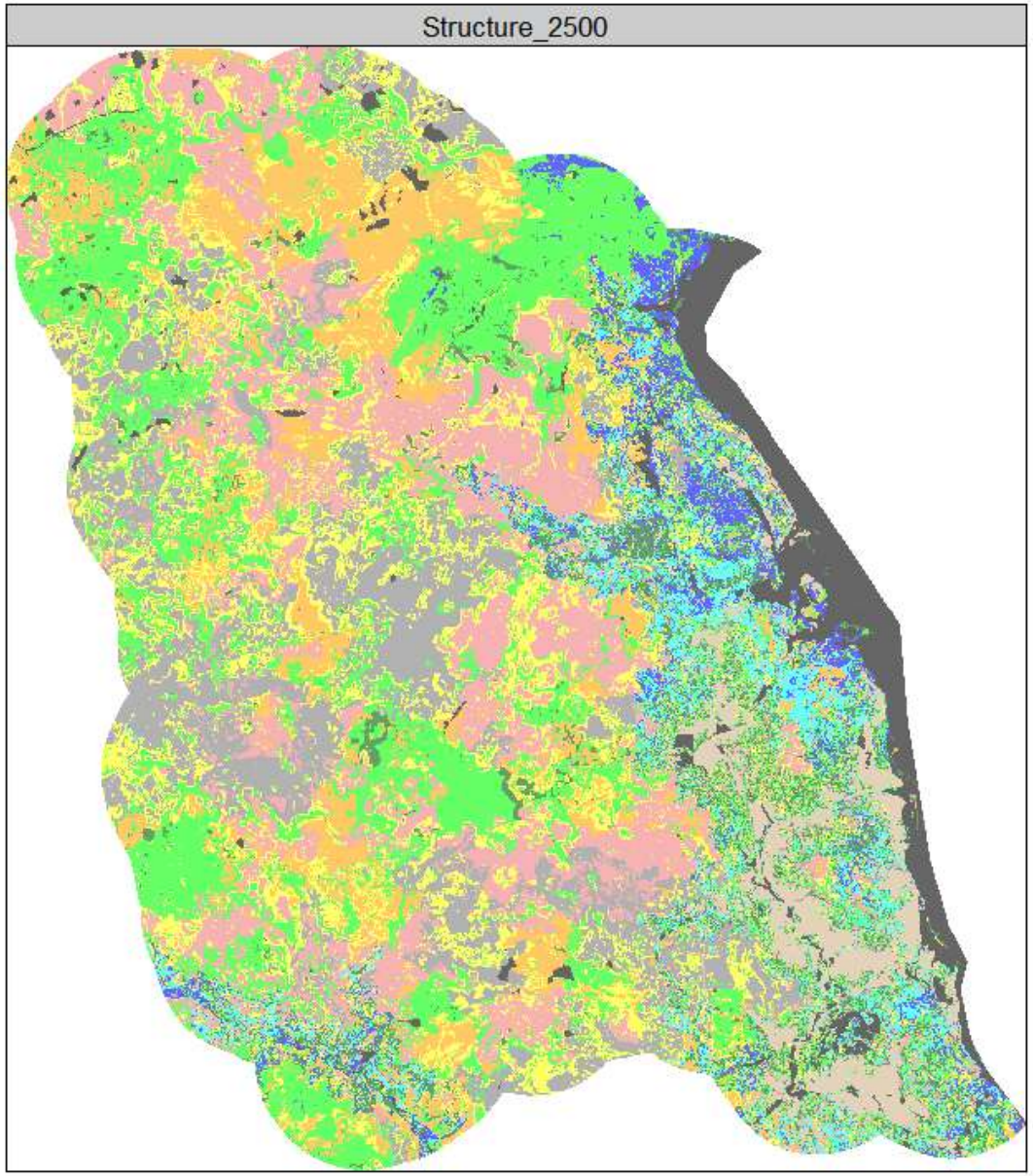


PFBG = Post Fire Bare Ground
SI = Stand Initiation
SEOC = Stem Exclusion Open Canopy
SECC = Stem Exclusion Closed Canopy

UR = Understory Re initiation
YFMS = Young Forest Multi Story
OFMS = Old Forest Multi Story
OFSS = Old Forest Single Story

- On average, 35% (16-58%) of cold mixed-conifer forests and 13% (4-25%) of dry + moist mixed-conifer forests acted as fire ‘fences’, areas of meadow, prairie, shrubland, sparse woodland, burned bare ground.

- This variability represents the larger landscape’s interactions with fire over time and the tug-of-war between factors growing and burning forest.



- The location of fences constantly shifts across the landscape.
- Fences only function for a short window of time, but new fences always emerge.
    - High severity fire creates regions of non-forest fences, burned and recovering areas.
    - Low and moderate severity fire patches shape the structure and composition of forest that remain on the landscape, canopy cover is typically open

Structure class: PFBG SI SEOC SECC UR YFMS OFMS OFSS

RESEARCH OBJECTIVES: UNDERSTANDING LANDSCAPE RESILIENCE

1) **Historical Landscapes**: what created resilience in the past?

2) **Aspen**: did hardwoods play a role in historical resilience, and could they play a role in the future?

3) **Future Climate**: how will the characteristics that create resilience change under future climates?

4) **Forest Management**: how can we use management tools to create these resilient characteristics?

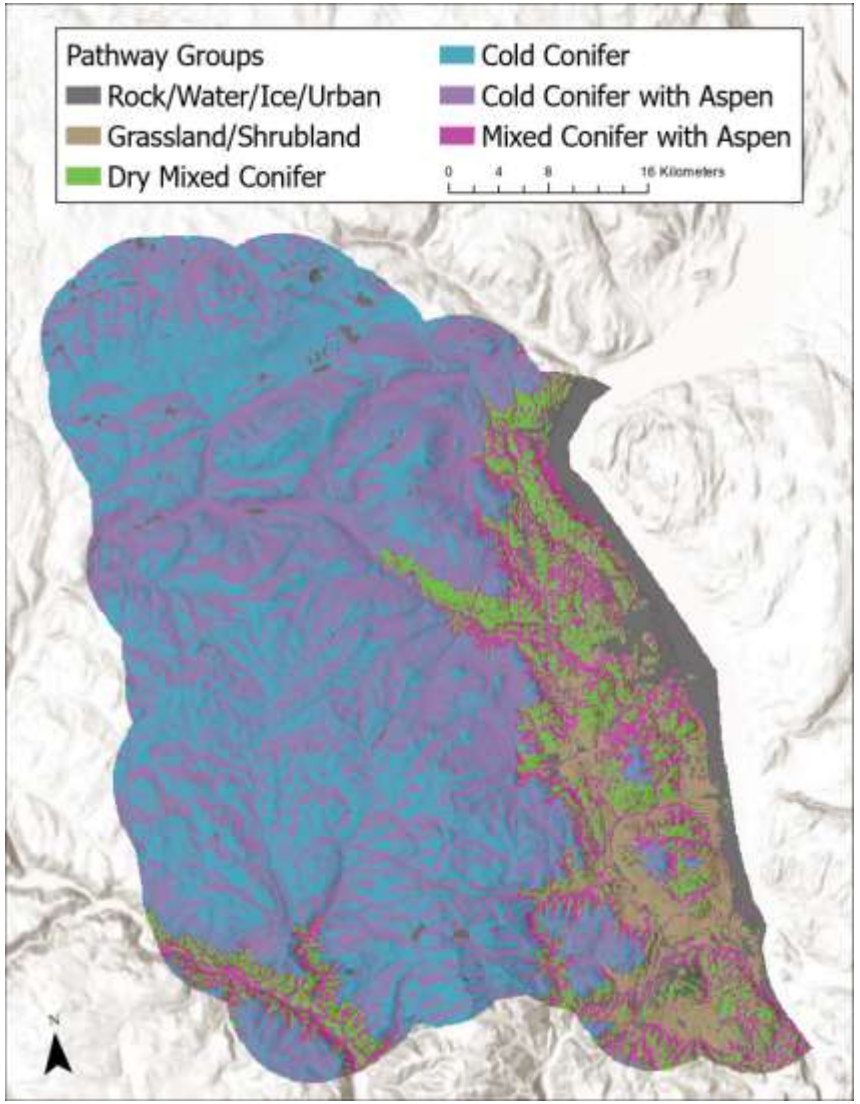
INFLUENCE OF ASPEN

Key research questions:

1. How much was present across the landscape? How did that vary over time?
2. How would the reintroduction of aspen influence the balance of forest and non-forest required to achieve a stabilized landscape?

Methodology:

- Mapped areas with potential for aspen growth based on tree feasibility maps & topoedaphic settings
- Created state transition models that reflect interactions between fire, forest structure and species composition



RESEARCH OBJECTIVES: UNDERSTANDING LANDSCAPE RESILIENCE

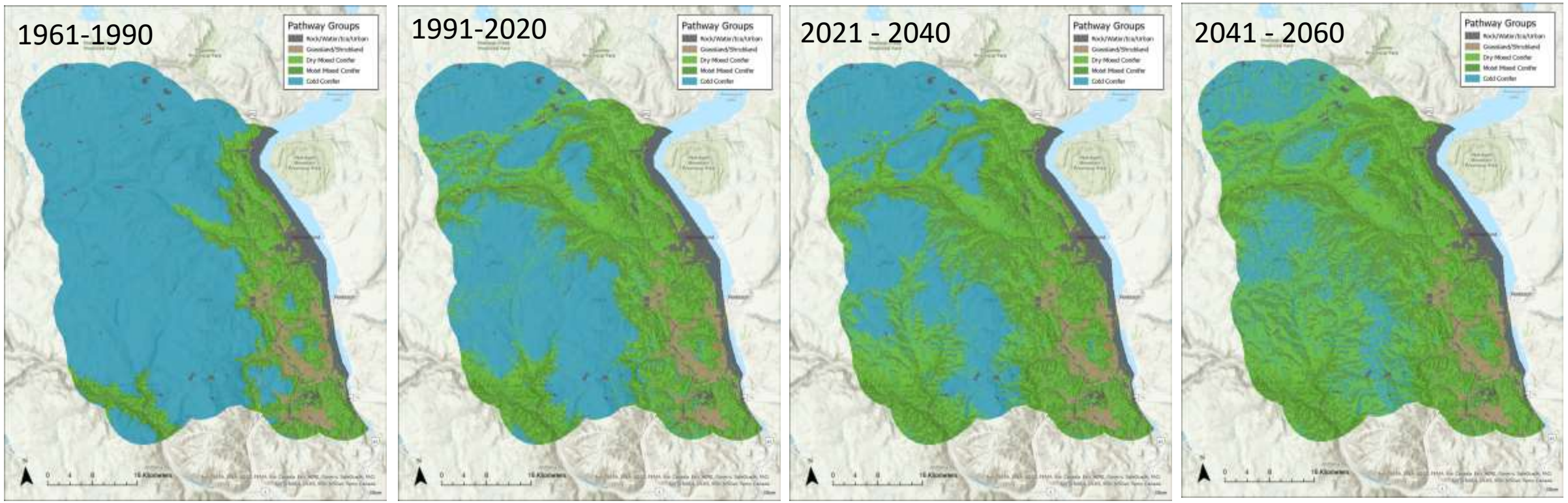
1) **Historical Landscapes**: what created resilience in the past?

2) **Aspen**: did hardwoods play a role in historical resilience, and could they play a role in the future?

3) **Future Climate**: how will the characteristics that create resilience change under future climates?

4) **Forest Management**: how can we use management tools to create these resilient characteristics?

CLIMATE CHANGE



How will changes in weather and shifting species ranges affect the conditions of a resilient landscape?

- Impact of changes in climate on daily weather and fuel moisture
- Shifting species ranges due to climate (using predicted tree feasibility ratings)

RESEARCH OBJECTIVES: UNDERSTANDING LANDSCAPE RESILIENCE

1) **Historical Landscapes**: what created resilience in the past?

2) **Aspen**: did hardwoods play a role in historical resilience, and could they play a role in the future?

3) **Future Climate**: how will the characteristics that create resilience change under future climates?

4) **Forest Management**: how can we use management tools to create these resilient characteristics?

FOREST MANAGEMENT

- Management activities will include clear cut, thinning and prescribed burning
- Need to add these disturbances into the state and transition models
- Want to understand how much needs to be treated and in what spatial arrangement

FUTURE WORK

- Develop REBURN for other additional regions in the province
  - Expand to other dry forest regions
  - Eventually adapt for other ecoregions (coastal and boreal forests)
- Incorporate indigenous burning practices into model simulations
- Integration with the Canadian Forest Service's carbon budget model

Thank you to the Pacific Institute for Climate Solutions for funding this research.

PICS
PACIFIC INSTITUTE FOR CLIMATE SOLUTIONS