

Landscape disturbance alters the diet composition and diversity of moose, a generalist herbivore

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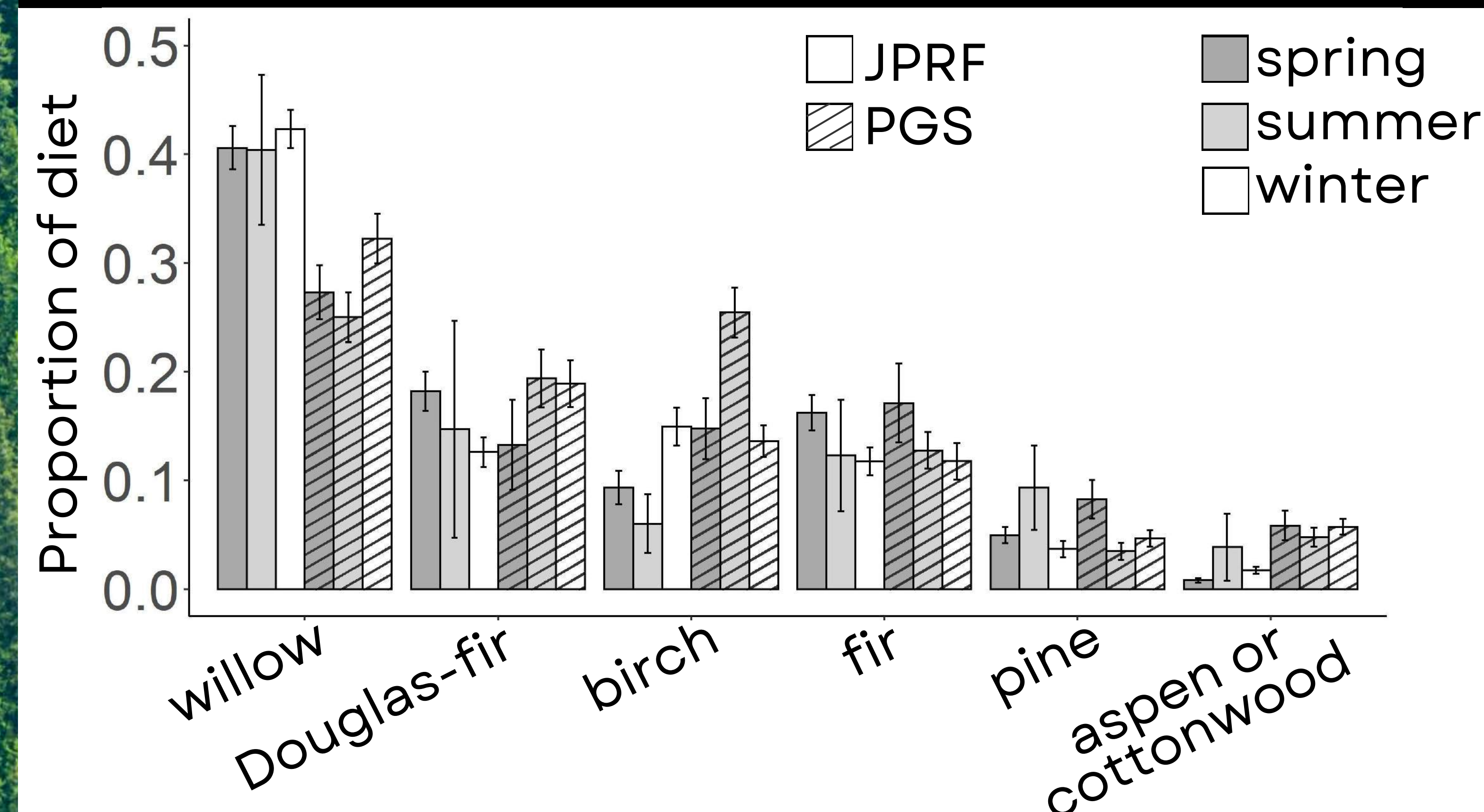
INTRODUCTION

- Across central BC, industrial forest harvesting has resulted in rapid change to forest structure and composition.
- Concurrently, moose populations have declined.
- We studied moose diet in two study areas that represented a contrast in logging intensity and rate of apparent starvation of moose.

METHODS

- Study areas: John Prince Research Forest and SW of Prince George
- Pellets collected by participants from local First Nations
- Microhistological analysis
- Explanatory variables of variation in moose diet:
 - forest harvesting and silvicultural methods
 - wildfire
 - habitat composition
 - broad-scale environmental factors
- Tested Niche Expansion vs Shrinkage Hypotheses

RESULTS



38.9%
Shrubs

29.7%
Fir and Douglas-fir

18.3%
Deciduous trees

4.9%
Other coniferous trees

4.4%
Forbs

Study area with more intensive forest harvesting

(-) shrubs, (+) diversity

Winter

(+) shrubs

Smaller cutblocks

(-) fir

Young cutblocks

(-) shrubs, (+) diversity

Herbicide application

(-) forbs, (+) diversity

Post-harvest prescribed burn

(-) shrubs, (+) diversity

Wildfire

(-) fir, (+) shrubs

Riparian habitat

(-) forbs

Precipitation

(-) deciduous trees

DISCUSSION

- Results support the Niche Expansion Hypothesis:
 - If disturbance results in decreased availability or quality of preferred forage resources, a generalist herbivore will compensate by consuming a greater diversity of plants.
- Relationship between increased forest harvesting and moose diet:
 - less shrubs and forbs
 - greater diversity of forage
- Forest harvesting affects moose diet differently than wildfires.
- Demonstrates plasticity in the diet of a generalist herbivore in response to broad-scale landscape disturbance.

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Post-wildfire contamination and source tracing in the Nechako River Basin

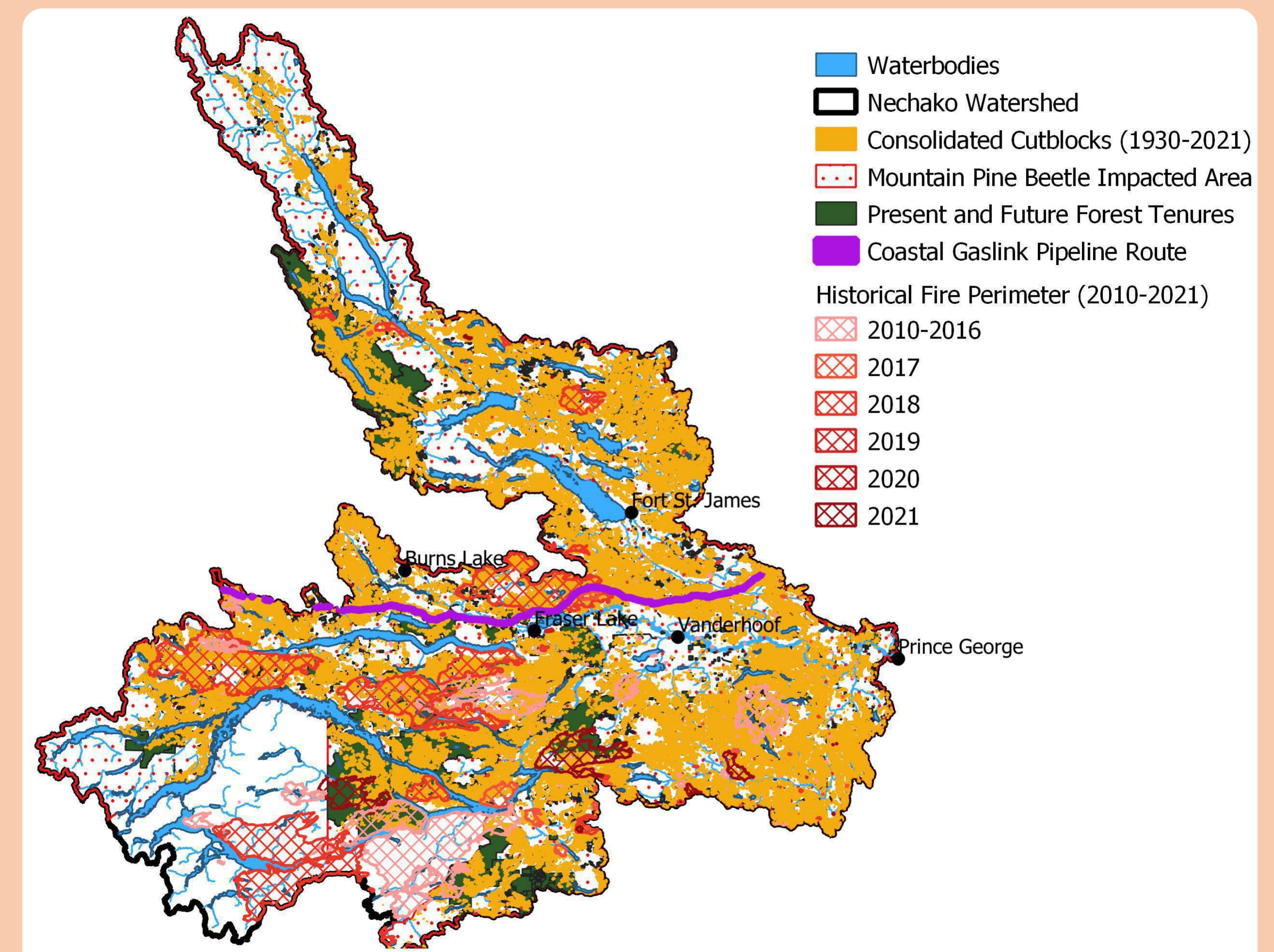
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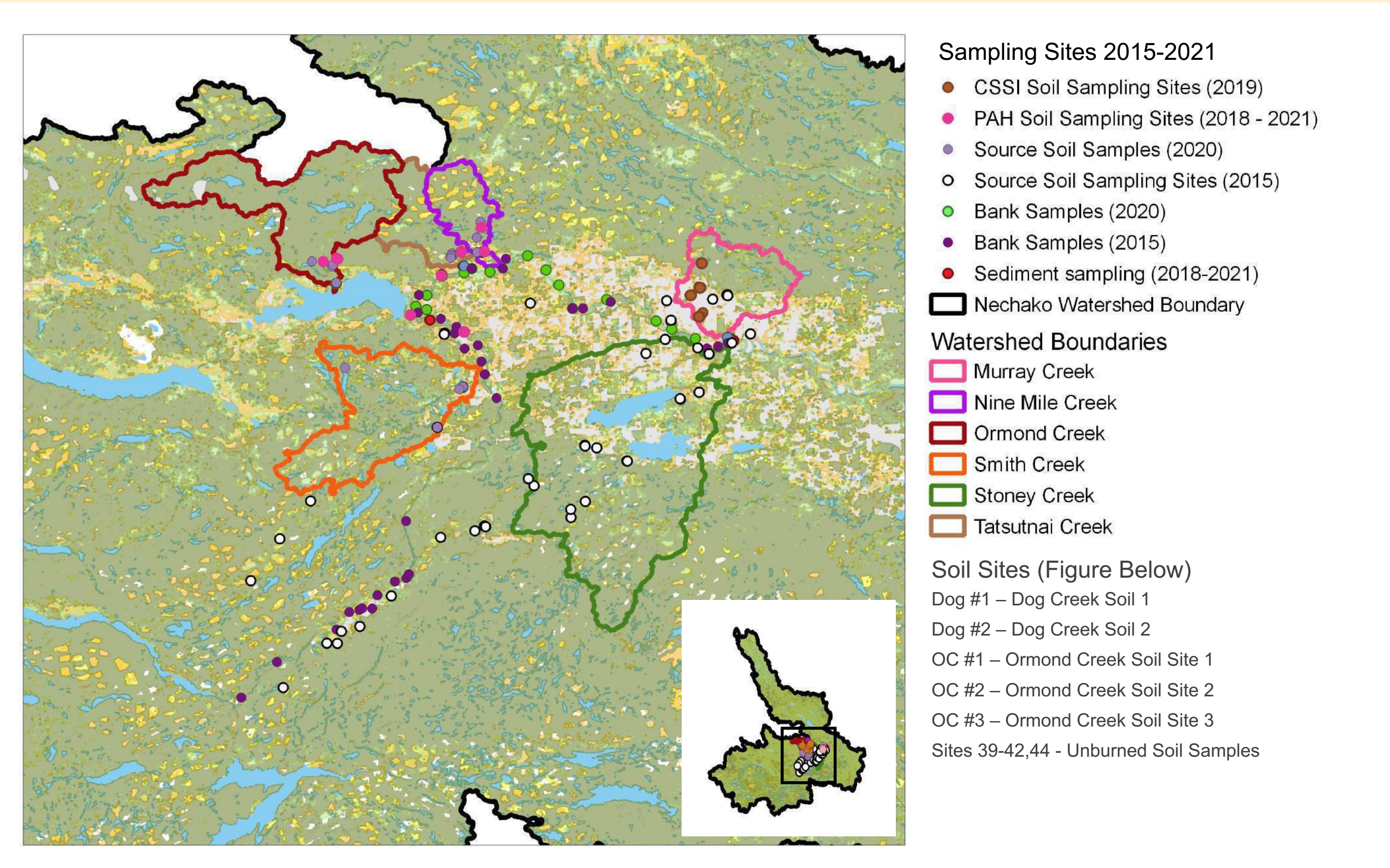
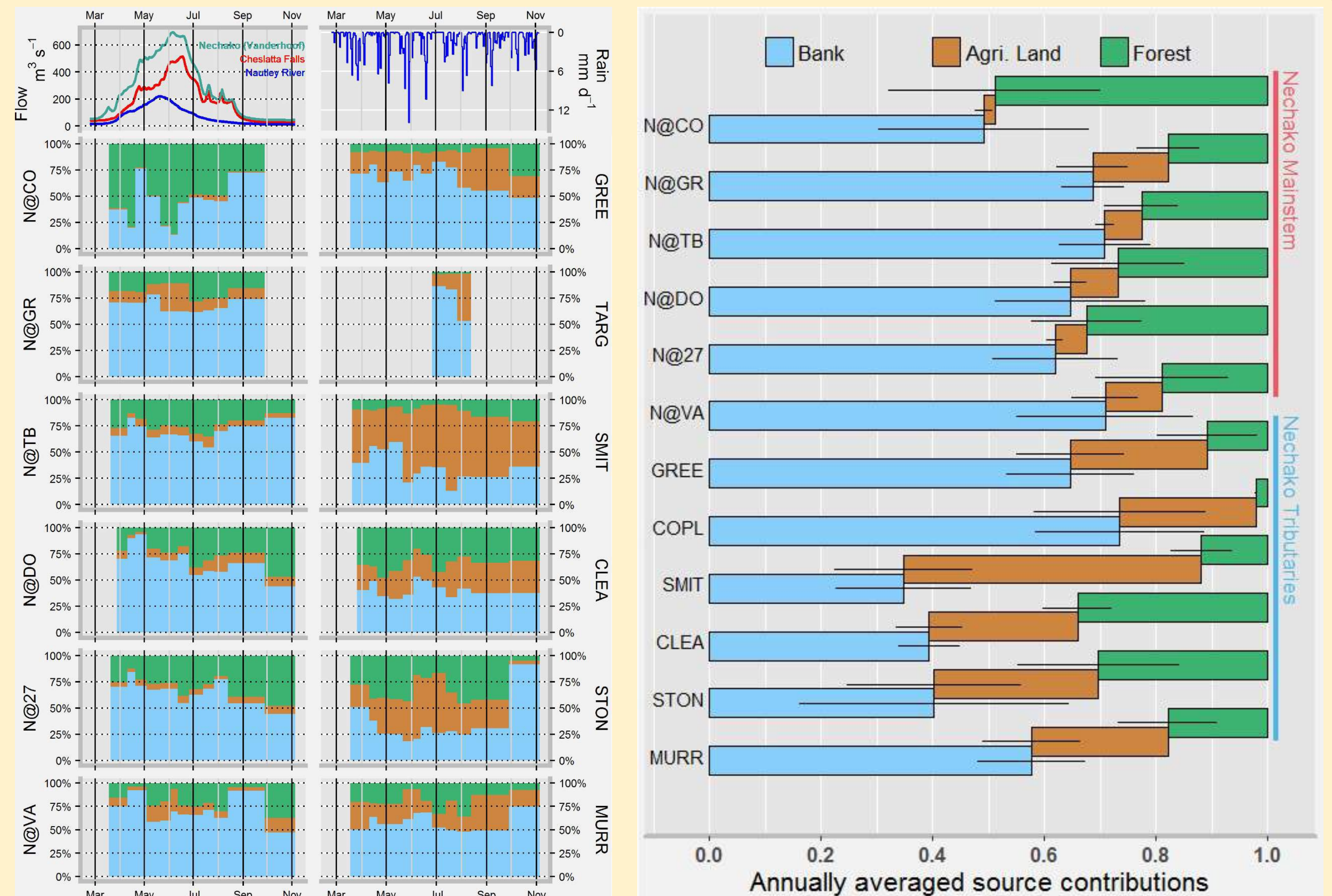


Why sediment?

- Sediment can be a contaminant
 - Clogs spawning habitat for Nechako White Sturgeon, chinook and sockeye salmon
- Sediment is a vector for other contaminants
 - Other contaminants such as metals, nutrients, and organic pollutants adsorb to sediment and are subsequently transported throughout the watershed
- Issues of excess sediment have been exacerbated by significant landscape changes in the Nechako River Basin



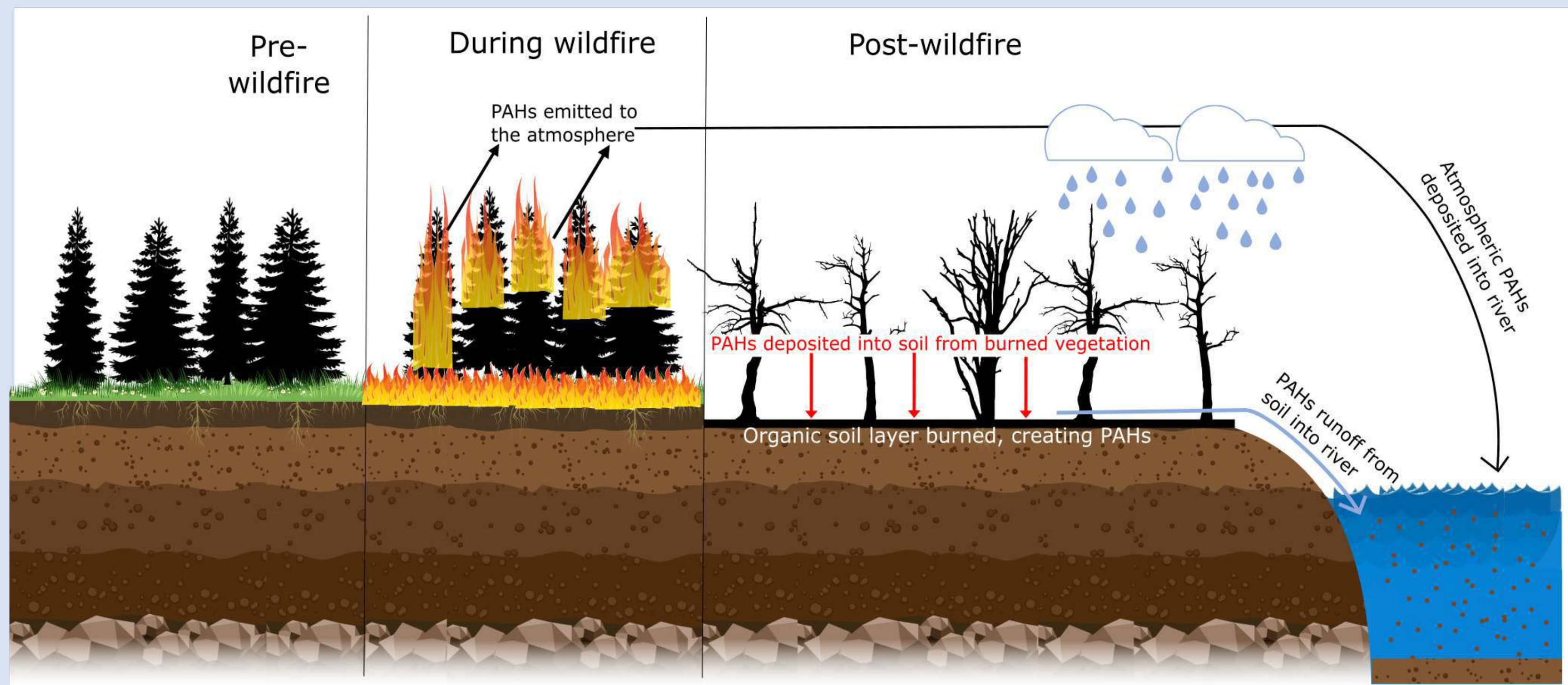
Basin Scale Sediment Tracing



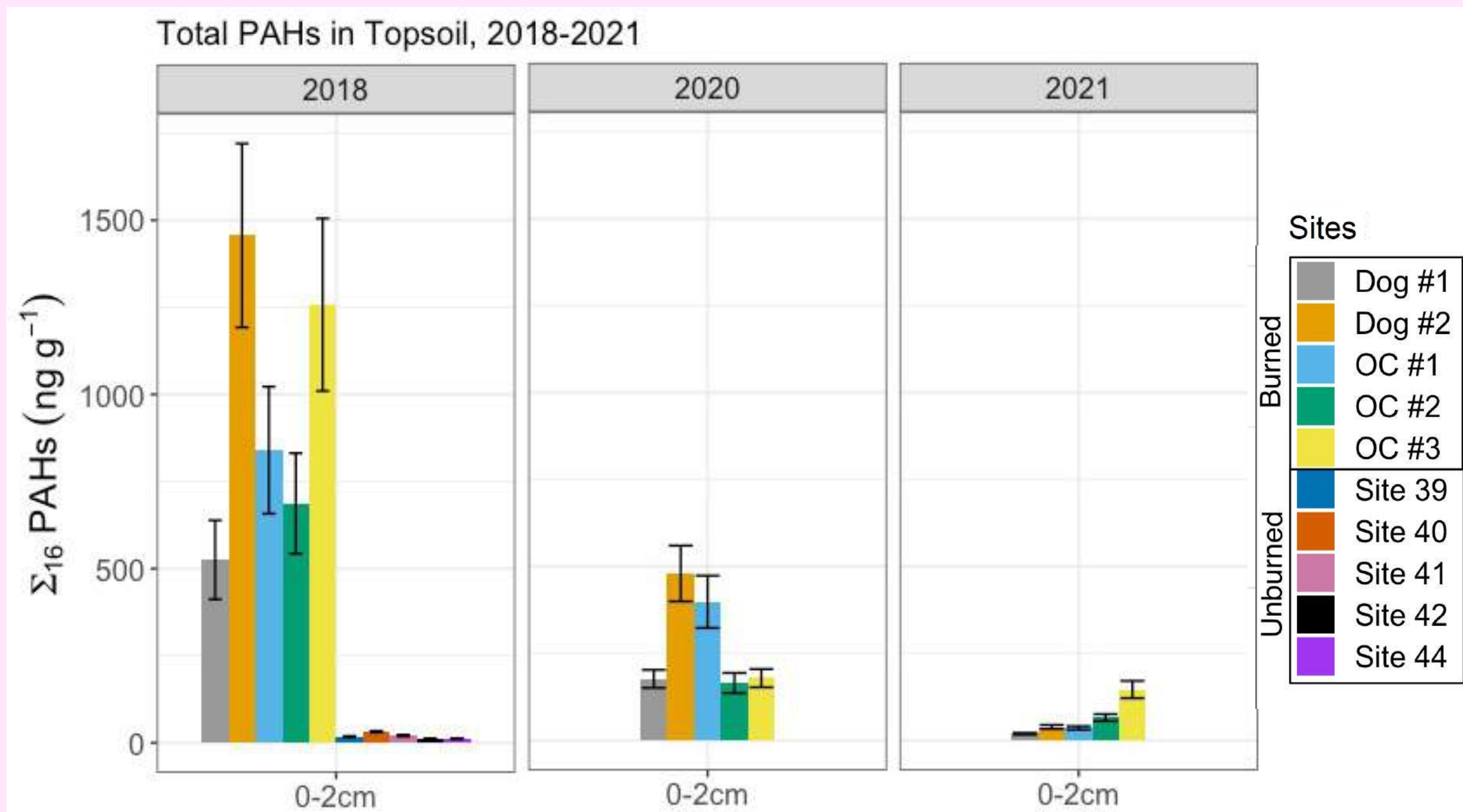
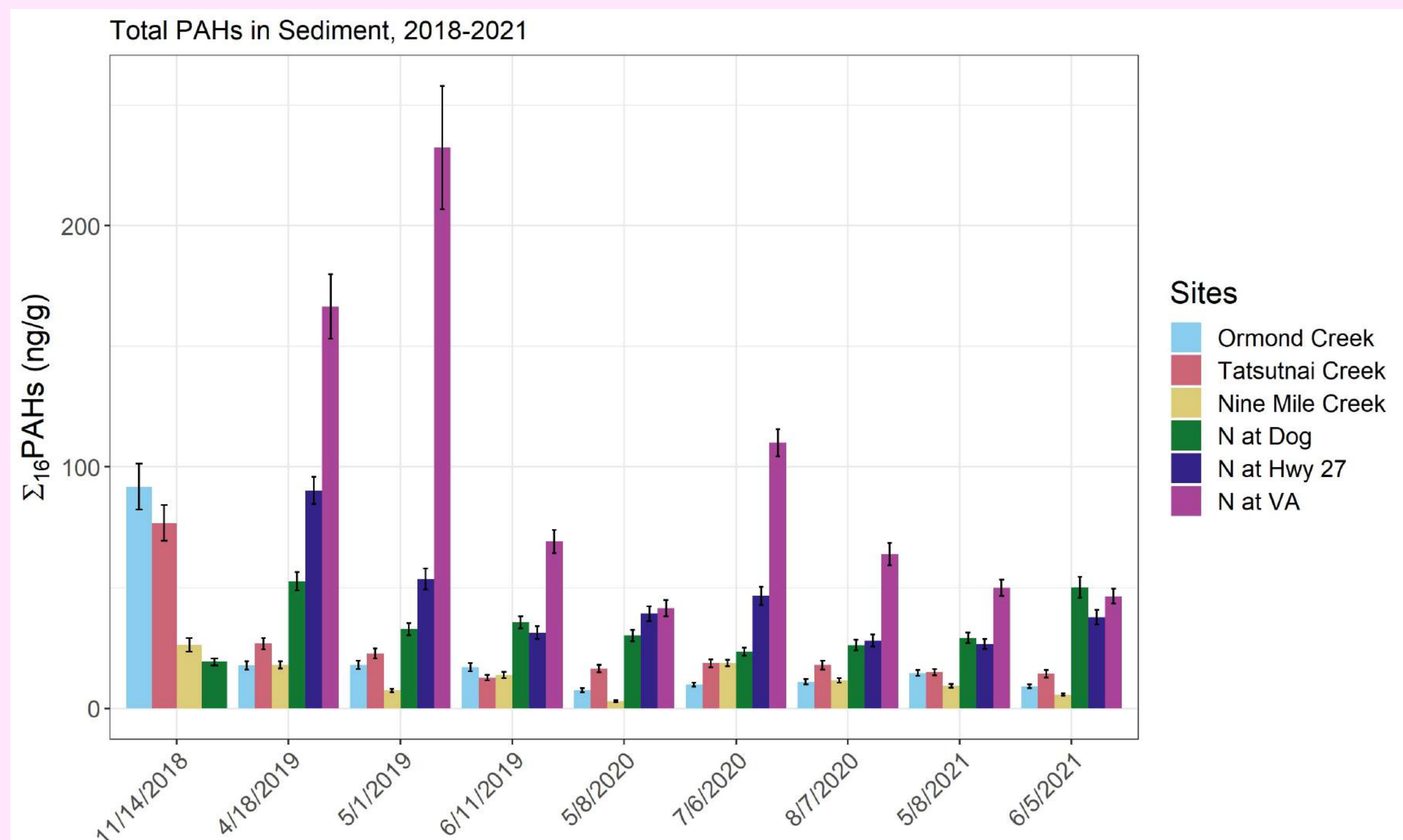
Initial research completed in 2015, update post-wildfires (2018-2021)

- A basin wide sediment tracing study was undertaken in 2015 and results showed banks to be the primary source of sediment in the Nechako River mainstem (i.e., N@CO, N@GR, N@TB, etc.), with more mixed sources in the tributaries (i.e., GREE, TARG, SMIT, etc.)
- Source soil samples collected from 2018-2021 focused on specific sub-basins, bank material from tributaries and the Nechako mainstem, and wildfire impacted areas
- Updated modeling intends to determine changes in source material in samples collected from 2018-2021 and more specific sources (e.g., burned and unburned forests, recent plantations vs. forested)

Growing Wildfire Threat



Burning trees and the forest floor will emit PAHs to the atmosphere and deposit PAHs into soils. Antecedent runoff events can lead to PAH transport to adjacent waterbodies due to overland erosion (short-range transport) and from PAHs in the atmosphere (long-range transport)



Determining concentrations of polycyclic aromatic hydrocarbons (PAHs) post-wildfire in the NRB

- Erosion and landslides occur after wildfire due to the potential for the creation of a hydrophobic soil layer as well as soils denuded of vegetation
- Concentrations of PAHs in soil collected in burned areas has decreased significantly since 2018, but concentrations are still above baseline
- In sediments, concentrations have decreased across all sites since 2018, but concentrations in the mainstem Nechako river are elevated, possibly due to other sources of PAHs

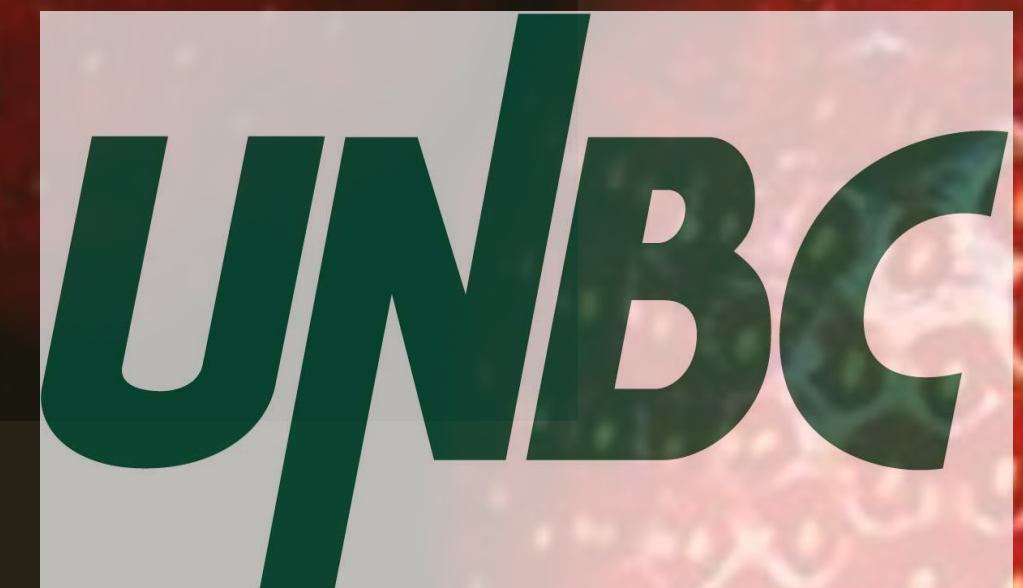
Effects of Glyphosate on Melatonin in Wild Strawberries under Three Different Environmental Conditions

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1. INTRODUCTION

- Glyphosate is a post emergent, nonselective, broad-spectrum, systemic herbicide (Duke, 2018; Lévesque & Rahe, 1992) used to control competitive vegetation in forests where wild strawberries grow in British Columbia (Govindarajulu, 2008).
- Melatonin is a plant hormone present in strawberries that acts as an antioxidant, growth promoter, cell protector and helps to combat biotic and abiotic stress conditions (Arnao & Hernández-Ruiz, 2015; Hernández-Ruiz et al., 2004).
- Glyphosate disrupts the precursors of melatonin (tryptamine and tryptophan) by blocking an enzyme, 5- enolpyruvyl shikimate -3- phosphate synthase (EPSPS), required for the biosynthetic shikimic acid pathway that produces the amino acids tyrosine and tryptophan (Duke et al., 2012).



Fig 1: Spraying of herbicide to control vegetation

2. OBJECTIVES

- To determine the changes in melatonin production after glyphosate treatment in wild strawberries.
- To determine the effects of three different temperatures and photoperiods on melatonin production in glyphosate treated wild strawberries.
- To determine the stress response in wild strawberries after glyphosate treatment.
- To determine the effect of temperature and light treatments on glyphosate to AMPA residues in tissues.

3. EXPERIMENTAL DESIGN

- Strawberry plants will be planted in three growth chambers (24 plants/chamber) under different temperatures and photoperiod conditions.
- Half the plants (12 plants) will receive an application of 50% operational dose of glyphosate (Vision Max®) and the other half (12 plants) will serve as a control.



Fig 2: An example of how plants will be divided between chambers for the experiment. 24 plants will be grown in each growth chamber with half of the plants (12 plants) treated with glyphosate and the remaining 12 plants acting as controls.

Trial 1

Temperature
Chamber 1 : 8°C/4°C
Chamber 2 : 12°C/6°C
Chamber 3 : 20°C/14°C
Photoperiod
12 hrs/day (constant)

Trial 2

Temperature
12°C/6°C (constant)
Photoperiod
Chamber 1 : 6 hrs
Chamber 2 : 12 hrs
Chamber 3 : 18 hrs

Trial 3

The photoperiod and temperatures of the growth chambers will vary, using the variations from Trials 1 and 2.

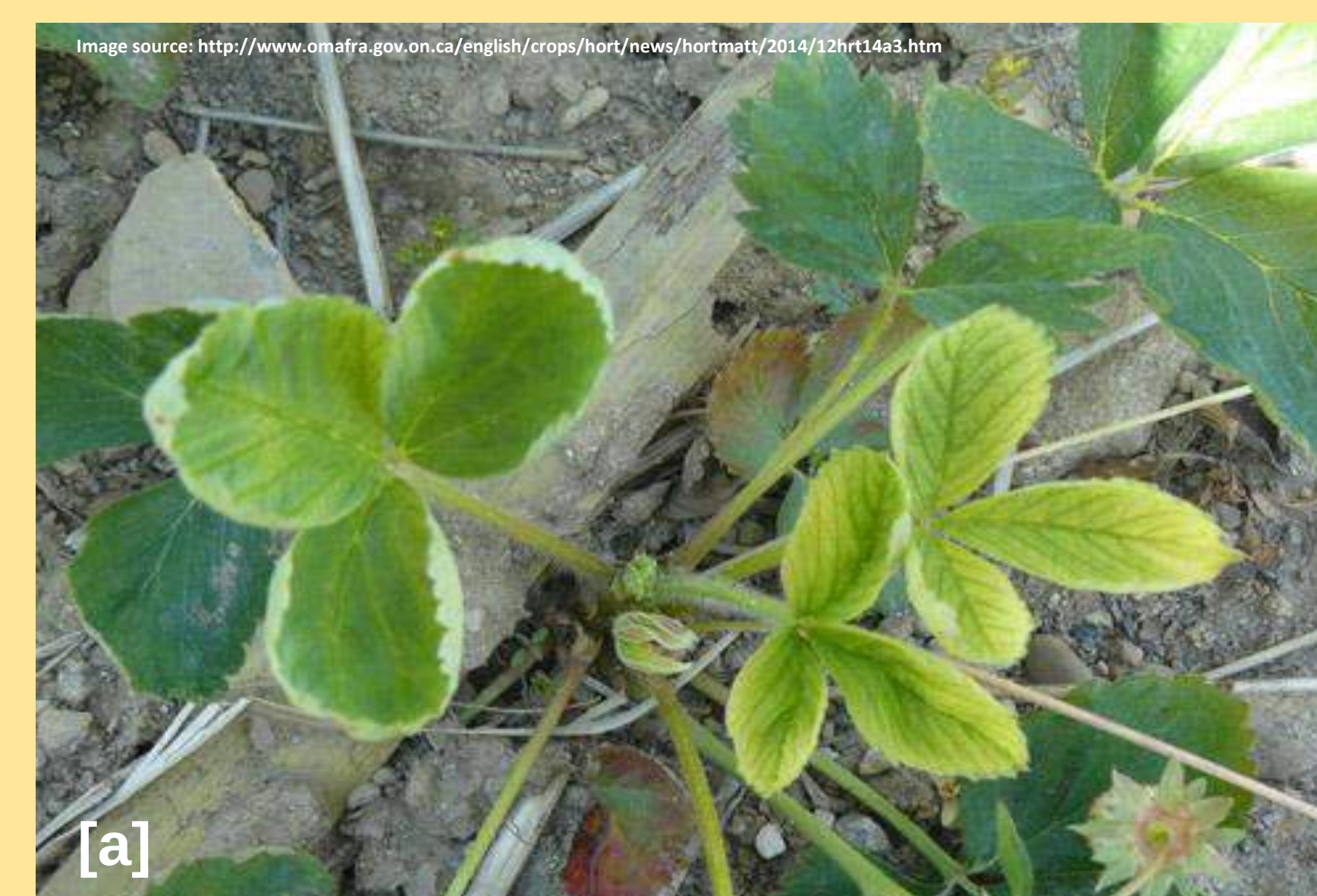
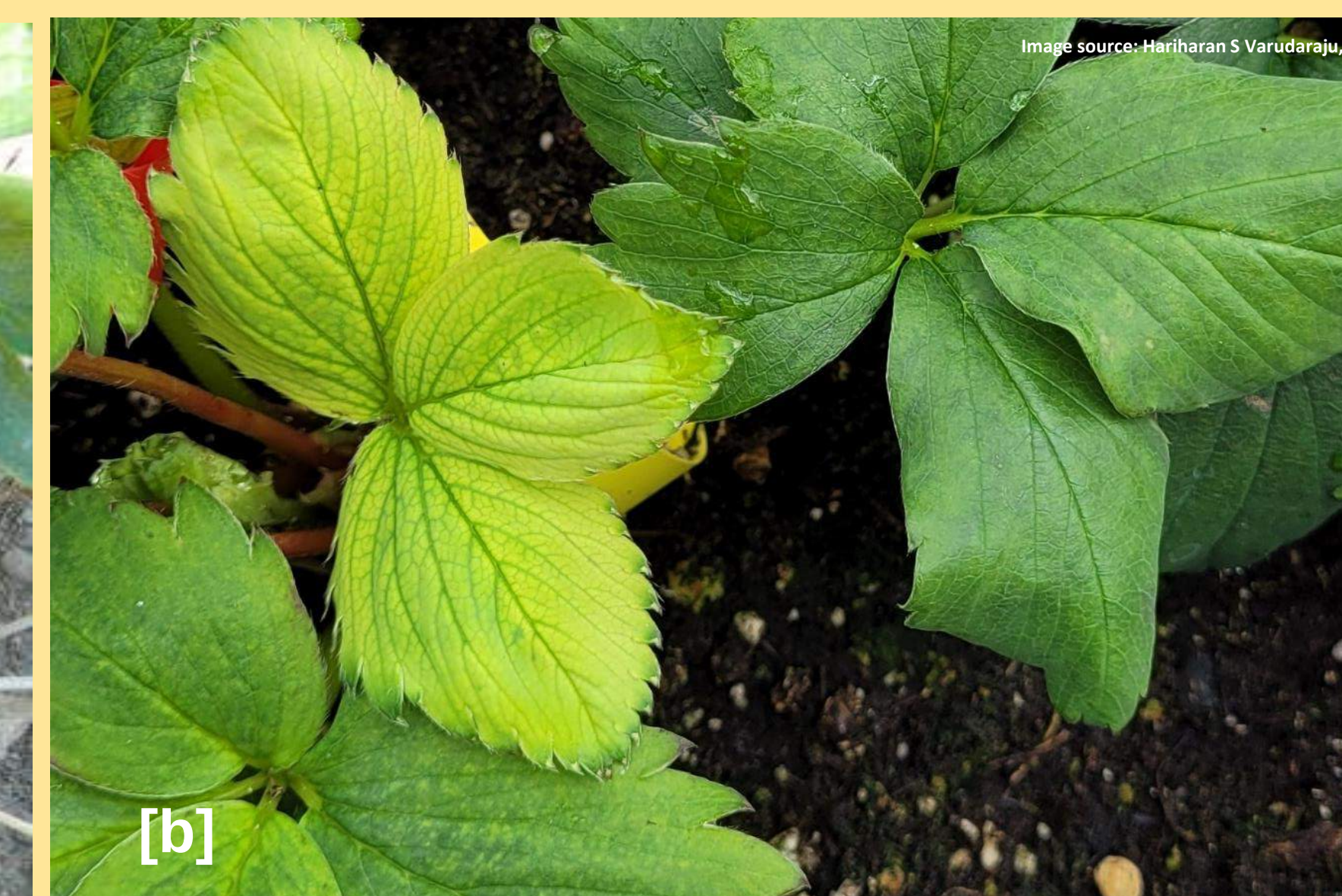


Fig 3a: Yellow colouring and cupped leaves are a common symptom of glyphosate injury in strawberries. Fig 3b: Appearance of chlorotic leaves when 50% of glyphosate were sprayed to actively growing strawberry plants at 20°C.



- Strawberry leaves will be collected from the growth chambers weekly for melatonin estimation. Plant leaf area, fluorescence and new leaves will be measured weekly as indicators of growth stress.
- Petiole length, root length, fresh and dry weight of shoot and root will be measured at the end of each trial.

4. MELATONIN ESTIMATION

The weekly collected leaf samples will be ground using liquid nitrogen and stored at -20°C. The samples will be analyzed using enzyme-linked immunoassay (ELISA) (analytical technique).

5. MEASUREMENT

- Leaf area will be measured using NIS-Elements (image analysis software).
- Fluorescence will be measured using chlorophyll fluorometer.
- The leaves that are unfurled are counted as new leaves
- Fresh and dry weight of shoot and root will be measured at the end of each trial.

6. EXPECTED OUTCOMES

1 Melatonin levels will be affected by glyphosate application as it disrupts the precursors (tryptophan and tryptamine) of melatonin.

2 Change in the duration of light exposure will alter the level of melatonin production as it is a light response molecule.

3 Stress factors such as low and high temperature will increase melatonin levels as it helps plants to overcome cold and heat stress conditions.

4 Leaf area and number of new leaves will be reduced due to glyphosate exposure and different environmental conditions.

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Committee members:
Dr. Hossein Kazemian & Dr. Darwyn Coxson

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Development of an Environmentally Friendly Wood-pulp-based Foam for Industrial Packaging

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Introduction

- ✓ Polystyrene (EPS) foam is a highly popular polyester packaging material with a wide application in food packaging.
- ✓ However, the recycling rate of EPS is limited. In Metro Vancouver, about 10,500 tons of EPS foam is disposed in landfills each year while till 2019, only 21% of those foams were recycled.
- ✓ With rising environmental concern about the degradation of petroleum-based products, finding sustainable, bio-based, and biodegradable substitutes has gained considerable interest.

Objectives

- 1- Make an environmentally friendly packaging foam (as a replacement for EPS foam) from wood pulp
- 2- Find alternative bio-based polymers as additives to the pulp foam matrix
- 3- Advance the pulp-based foam insulation and mechanical strength

Sustainable Approach

- ✓ Cellulosic materials as renewable and biodegradable resources are considered the main candidates to produce biodegradable foams due to their outstanding characteristics, such as;
 - Highly porous structures
 - Ultralow density
 - High surface area
 - High fluid permeability
 - Mechanical properties
 - Intrinsic characteristics of being renewable, biodegradable, and non-toxic
- ✓ Wet foam technique as a simple process is considered for this project with the potential for industrial scale production:
 - Stable wet foams synthesis using surfactant or particles as stabilizing agents
 - Addition of reinforcement agents like lignin
 - Drying wet foams in an oven/air

Methods and Materials



Pulverization & Soaking



Cross-linking Reaction & Polymer Addition



Foam Stabilization

- ✓ 1,2,3,4-butane tetracarboxylic acid (BTCA)
- ✓ Citric acid
- ✓ Polylactide (PLA)

- ✓ Sodium dodecyl sulfate (SDS)
- ✓ Polysorbate 80 (TWEEN® 80)

Filtration and Drying



Characterization

- Cell Structure: Scanning Electron Microscopy (SEM)
- Mechanical Properties: compression testing (CT), Dynamic Mechanical Analysis (DMA)
- Thermal Analysis
- Thermal Insulation Evaluation
- Liquid Absorption Capacity

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EFFECTS OF LANDSCAPE CHANGE ON CERVID-PARASITE RELATIONSHIPS IN INTERIOR



NORTHERN BRITISH COLUMBIA

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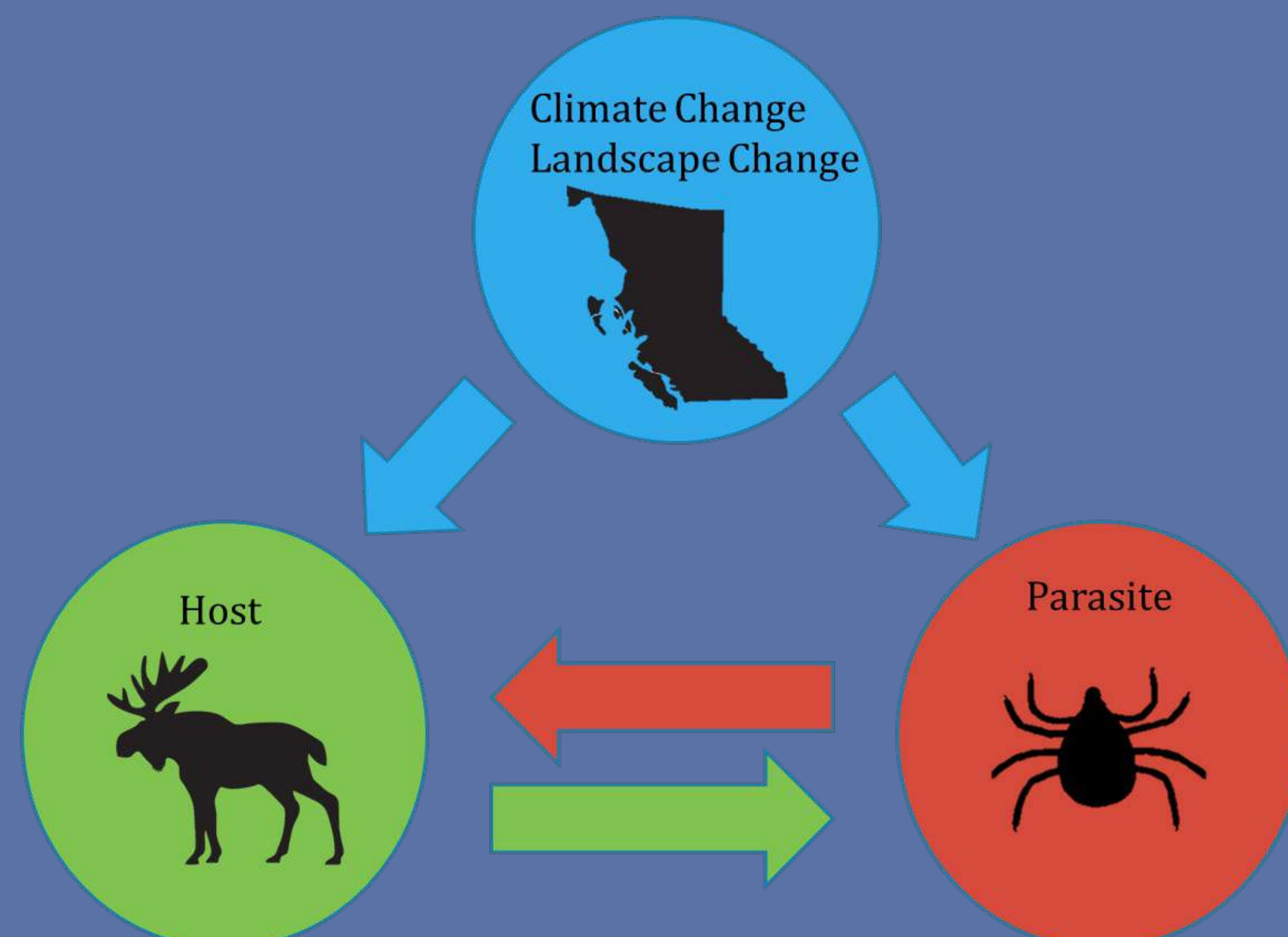


Background

- Climate and landscape change can affect host-parasite interactions profoundly
- Substantial landscape change has occurred recently in interior BC due to salvage logging following the mountain pine beetle epidemic, which could influence host-parasite interactions
- Effects on moose (*Alces alces*)
 - Decrease of up to 70%
- The British Columbia Moose Research Project (BCMRP) is an ongoing, decade-long study working to understand the causes of moose declines
- Winter ticks (*Dermacentor albipictus*) are endemic ectoparasites on moose which may cause hair loss, mortality in calves, and anemia
- Female winter ticks feed on moose blood between fall and spring and then drop onto the ground and lay eggs
- Larval ticks live in leaf litter until they attach to moose in the fall
- Understanding the environmental conditions that influence larval winter tick survival and density could help predict areas where moose are at risk of infestation

Research Questions

- What habitat features influence the density of larval winter ticks in fall?
- How do temperature and humidity influence the survival of larval winter ticks over the summer?



Methods

- Larval tick surveys: Sept.-Nov. 2021 in Prince George South study region
 - Early, Recovering, Regenerating
- We sampled ~4 days a week weather depending
- Flannel 1x1 white sheets taped to wooden dowels as flags
- Dragged for 250 m
- Habitat data recorded at start, middle, and end
 - Canopy cover
 - Soil depth
 - Biogeoclimatic Ecosystem Classification (BEC) Zone
 - Humidity, Temperature, and Windspeed
 - Hip
 - Ground
- Larval tick survival experiments: to be set up in spring 2022 and 2023



Figure 1. Searching for larval winter tick using flannel flag



Figure 2. Collected larval winter tick from flagging

Results

- Total of 44 sites visited
- 4 sites with winter tick present
- Winter tick larvae were found in one site from random site selection
- ~70 winter tick larvae found total
- Other studies have observed winter tick infestations in moose based in PG South/Omineca study area to be 17%
- Additional analyses to predict infestation with winter tick prevalence

Future Work

- Future collaboration on:
 - Identifying individual and environmental variables associated with winter tick infestations on moose
 - Evaluate the effects of microclimate and stand characteristics on larval tick survival

Partnerships

- This project is being done collaboratively between UNBC and the BC Provincial Moose Research Group. Specifically, our research uses moose collar locations and winter tick prevalence data collected from moose at capture combined with additional, field-collected data on larval winter ticks. These analyses will contribute to better understanding of moose-tick interactions that may be useful in mitigating and predicting the effects of winter ticks on moose.

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Long term persistence of glyphosate in forest plant tissues & related impact on plant nutrient levels



Nicole Botten, MSc Natural Resources and Environmental Studies – Biology (Nicole.Botten@alumni.unbc.ca)

Supervisors: Dr. Lisa Wood and Dr. Art Fredeen, Ecosystem Science and Management Program, University of Northern British Columbia, Prince George, BC

Collaborator: Dr. Jeff Werner, BC Ministry of FLNRORD

Introduction

Glyphosate-based herbicides (GBHs) are highly effective, nonselective herbicides used worldwide in both agricultural and forestry applications. GBH is used in the Canadian forest industry to remove vegetation competing with commercially important conifer tree seedlings during reforestation of harvested cutblocks. While it has been widely researched for agricultural applications, relatively little research has been conducted regarding forest applications of GBH.



Figure 1: Fireweed regrowth below alder trees sprayed by glyphosate 3 years ago.

Persistence of Glyphosate in Plant Tissues

In a forest setting, many plants may receive a sublethal dose and thus survive after being treated with GBH (Boutin et al. 2014), especially in the understory. Glyphosate in surviving plants may be stored in plant tissues and may persist for an extended period of time (Wood 2019), even moving to different parts of the plant (Gomes et al. 2014).

Chelation & Effects on Nutritional Quality

Glyphosate is a chelating agent, which means that it binds to metals, with the possible result of hindering nutrient uptake and availability in plants (Mertens et al. 2018). Reduced nutrient content in plants may be a contributing factor in the poor health of moose in BC (Kuzyk et al. 2017) and could also pose a health risk for other animals, including humans, consuming the plants.



Figure 2: Root sample collection

Research Objectives & Questions

To determine the duration of glyphosate persistence in tissues of perennial plants that may have survived glyphosate-based herbicide application in a natural forest setting in two biogeoclimatic (BEC) zones (BWBS – Boreal White and Black Spruce, and SBS – Sub-Boreal Spruce), and to assess these plant tissues for altered nutritional quality due in part to chelation by glyphosate.

1. If a plant has survived treatment with glyphosate, does it retain glyphosate in its tissues?
2. If glyphosate persistence is discovered in plant tissues, what is the duration of the persistence?
3. Does the application of GBH and/or presence of glyphosate in plant tissues affect nutrient concentrations in plant tissues?

Methods

Root and shoot samples of four plant species (fireweed, red osier dogwood, red raspberry, and willow) were collected from glyphosate-treated and untreated areas of forest cutblocks in each of two BEC zones, at 1, 3, 6, and 12 years after treatment. Raspberry and blueberry fruit were collected from one BEC zone, one year post-treatment.

Samples were washed, dried and ground to a powder. High performance liquid chromatography – mass spectrometry (HPLC-MS) was used to analyze for presence of glyphosate and AMPA (glyphosate metabolic product). Inductively coupled plasma mass spectrometry (ICP-MS) was used to determine total metal nutrients.

Variation in presence and concentrations of glyphosate and AMPA were compared between treated and control samples, by species, zone, tissue type, and over time. Nutrient concentrations were compared between treated and control samples, and compared with documented nutritional requirements of ruminants.



Figure 3: Red Raspberry plant 1 year after treatment by glyphosate-based herbicide.

Results: Glyphosate Persistence

Glyphosate was detected in all plant tissues, including new shoot and fruit growth, for a minimum of one year after treatment, and at least six years in the shoots and 12 years in the roots of some species.

Samples from the drier, colder, more northern BEC zone retained significantly higher levels of glyphosate for longer than samples collected from the warmer BEC zone.

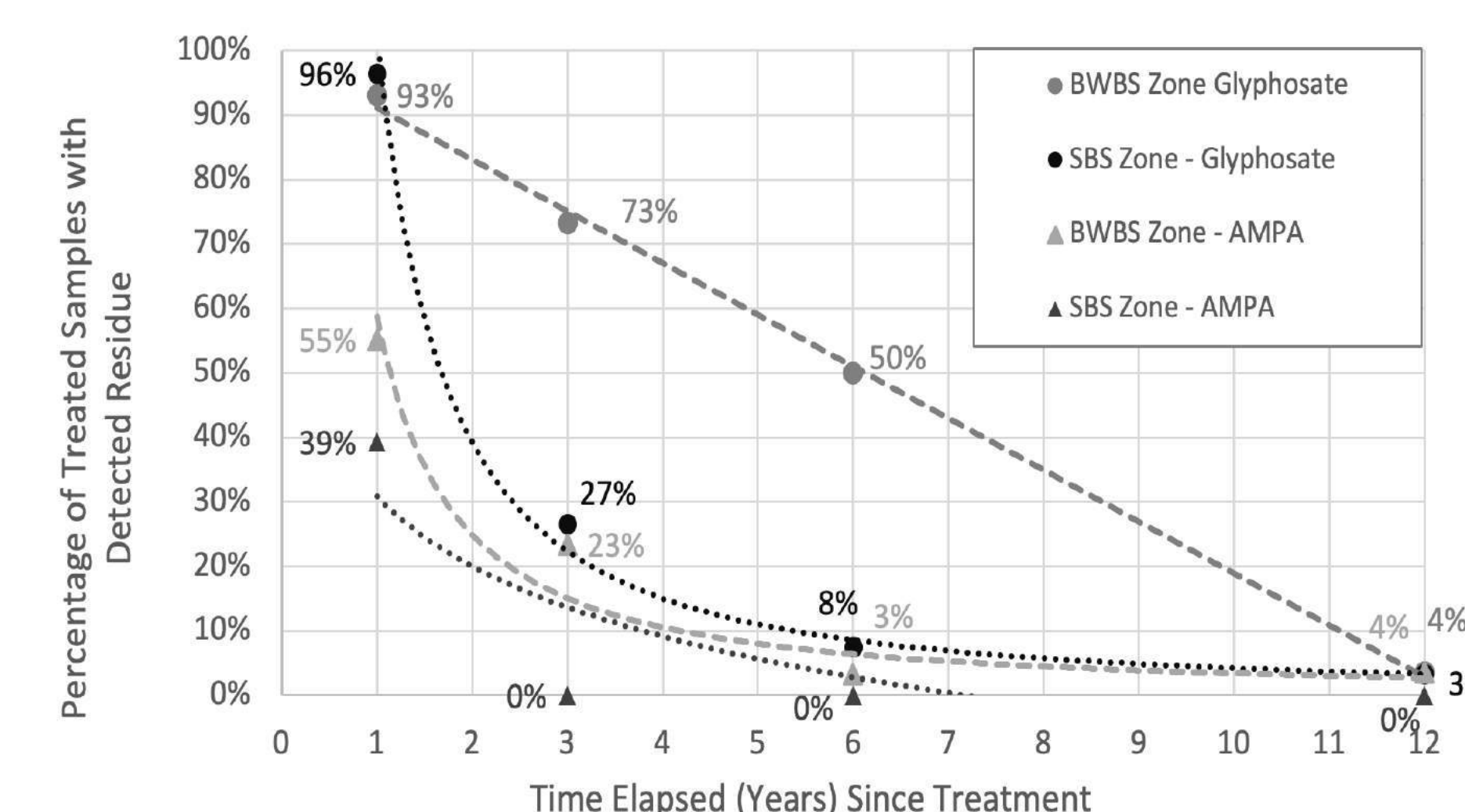


Figure 4: Proportion of GBH-treated samples with detected glyphosate and AMPA residues, by time and biogeoclimatic (BEC) zone. Fireweed and willow samples only (those sampled in both BEC zones).

Results: Plant Nutrients

Nutrient concentrations were more variable over time in treated samples than in control samples, and comparison of treated and control samples resulted in significant differences in 47 % of all cases.

Generally, Ca, Mg and Ni decreased with treatment in all three species; Zn increased with treatment for each species; and Fe and Mn had inconsistent changes with treatment.

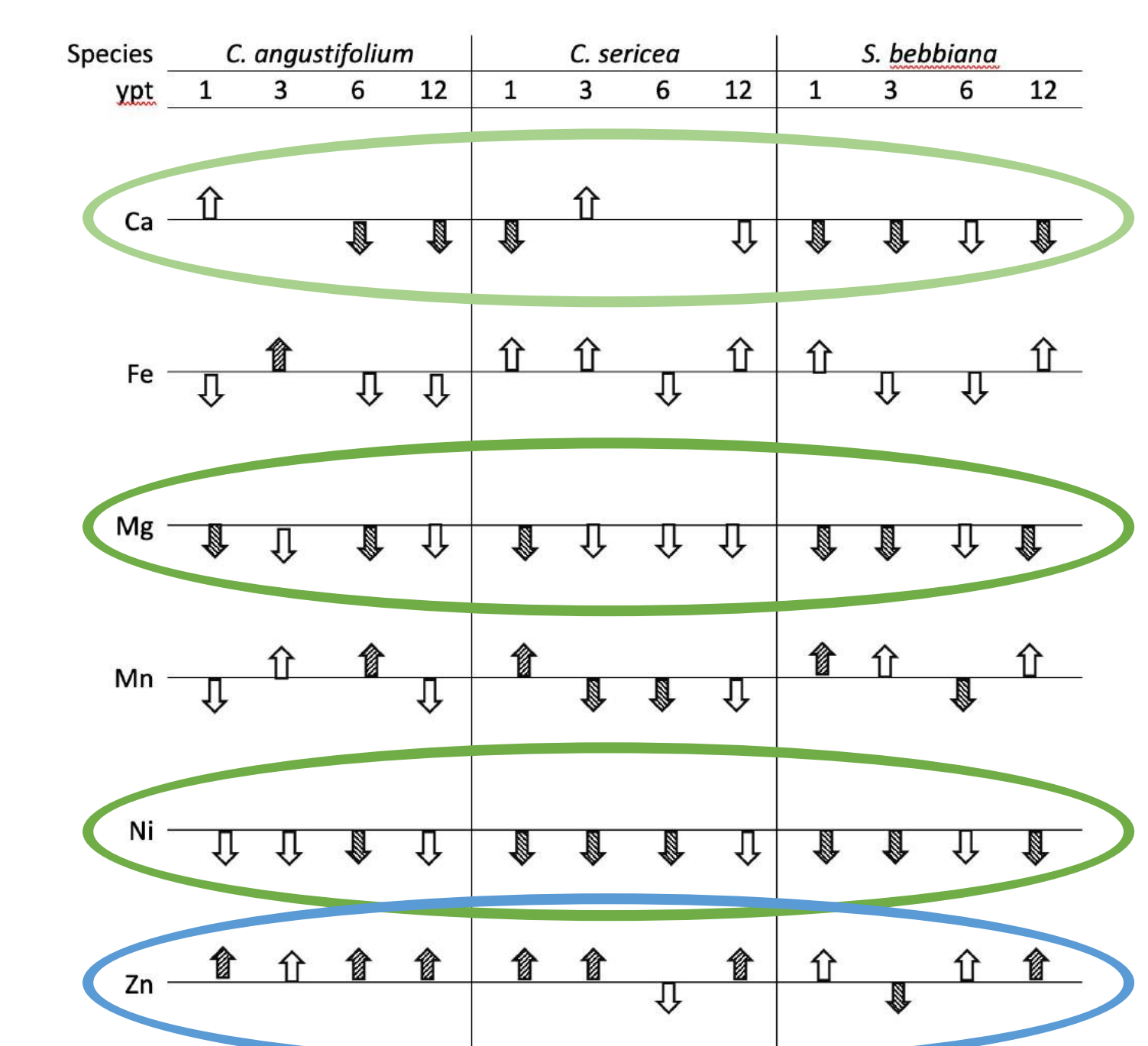


Figure 5: Comparison of control and treated shoot samples of 3 species at 1, 3, 6, and 12 years post treatment (ypt). Arrows indicate direction of change in nutrient concentration with treatment. Shaded arrows indicate statistically significant changes.



Figure 6: Moose commonly eat fireweed.

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Forest Management Impacts on Tree Species Diversity: Effectiveness and Costs in Light of a Beetle Epidemic

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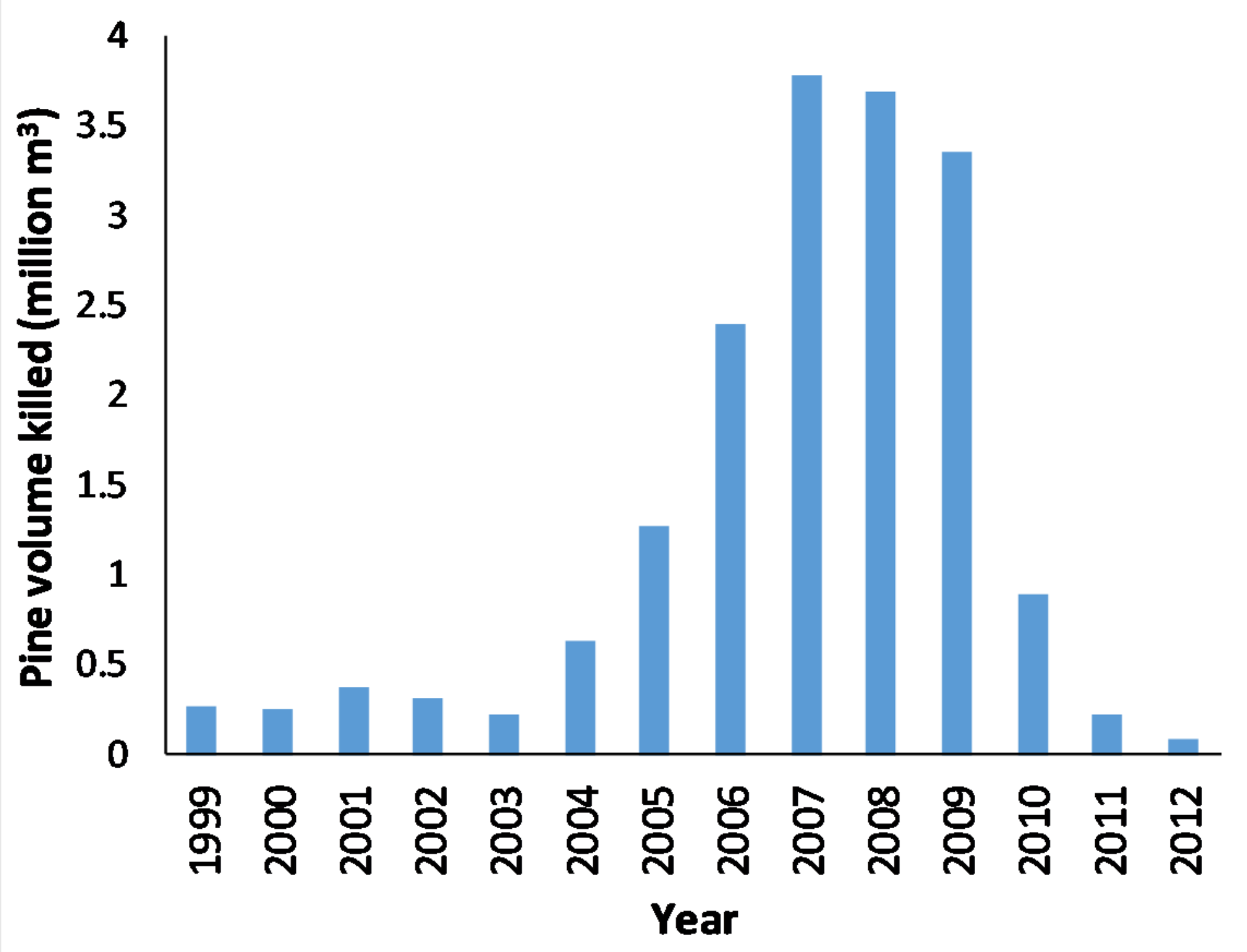
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Introduction

- In western North America, a recent epidemic of mountain pine beetle (*Dendroctonus ponderosae*) caused widespread forest mortality as a result of warmer winters (Figure 1).
- Insect outbreak frequency and severity is expected to increase under climate change
- The insurance hypothesis states that in a fluctuating environment “biodiversity insures ecosystems against declines in their functioning because many species provide greater guarantees that some will maintain functioning even if others fail.” Yachi and Loreau 1999

Purpose
Assess the effectiveness of applying the insurance hypothesis theory to a managed landscape that has experienced severe climate change impacts using modelling.

Figure 1. Volume of *Pinus contorta* and *Pinus ponderosa* (pine) killed by mountain pine beetle annually in the Merritt Timber Supply Area, British Columbia, Canada. (BC Government 2015)



Methods

- Historical retrospective
- Simulation of a forest estate 1980 – 2060
 - CASH6 model, similar to timber supply methods
 - Post-beetle harvest rate determined based on growing stock, growth rates, and a consistent flow of timber
- Cost/Benefit analyses

Figure 2. Study area: the Merritt Timber Supply Area (TSA), British Columbia, Canada. It is 1.1 million ha, with a cold and dry climate.

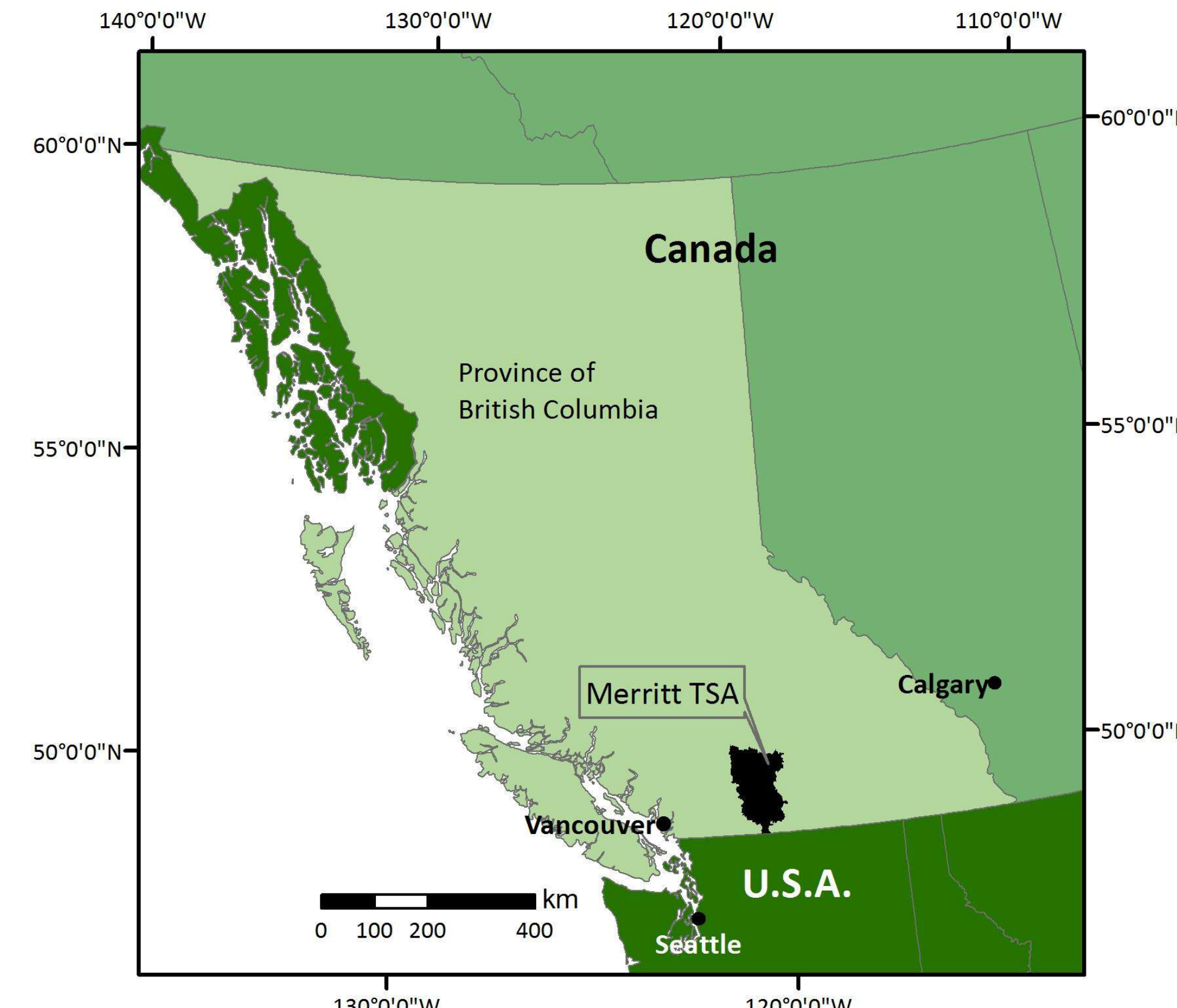


Table 1. Management strategies assessed		
	Pre-beetle Harvest assumptions	Planting assumptions
Business as usual	Volume and species based on statistics	Historical based on statistics and future based on existing timber supply analysis
Mixed planting	Same as Business as usual	Mixed species planting on appropriate sites
Early pine cut, mixed planting, more natural regeneration	Volume based on statistics but prioritized harvest of pine and including partial cutting	Mixed species planting on appropriate sites and more natural regeneration especially in partial cut areas

Results

Figure 3. Landscape-scale diversity

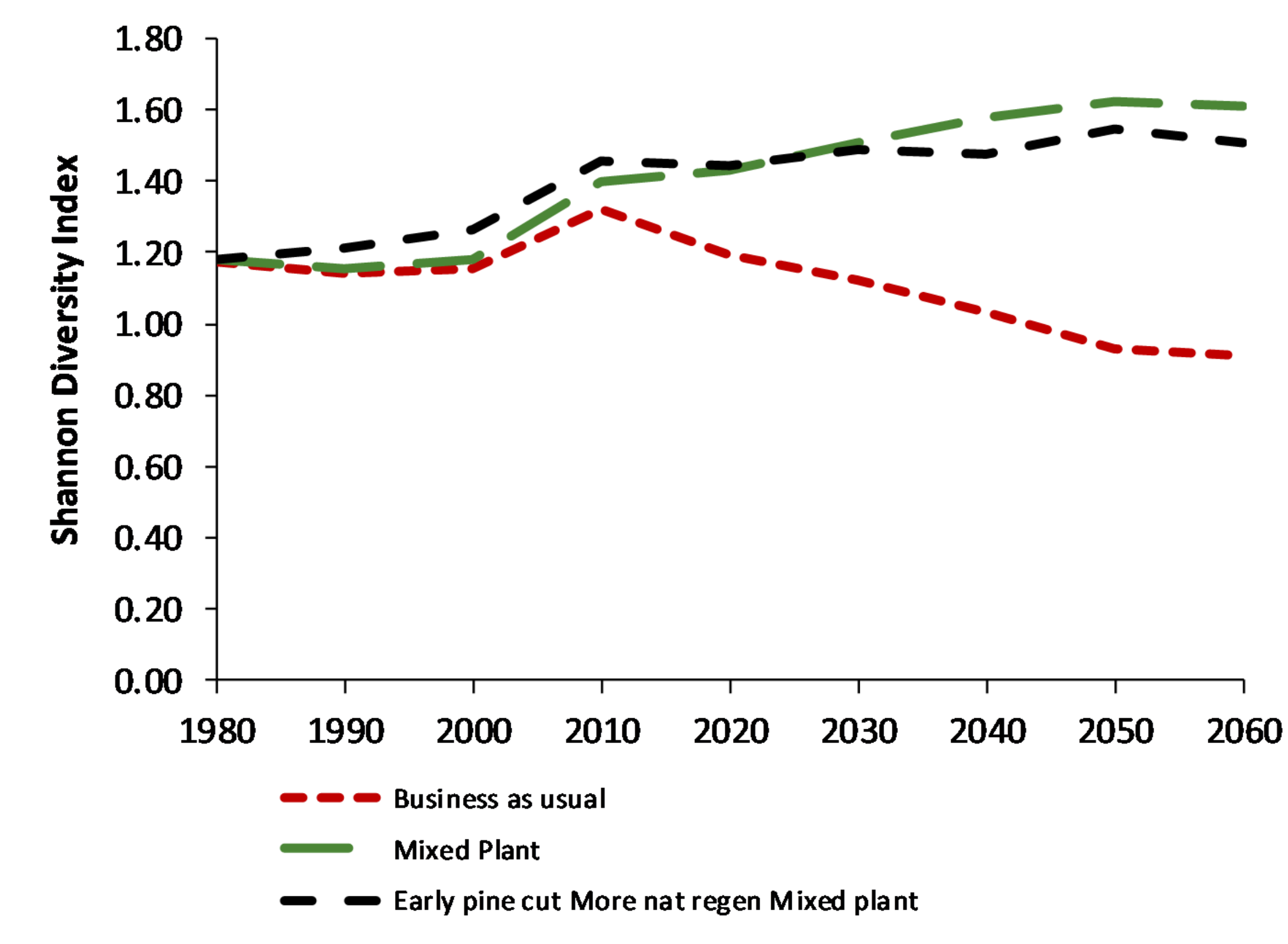


Figure 4. Volume in living trees per decade.

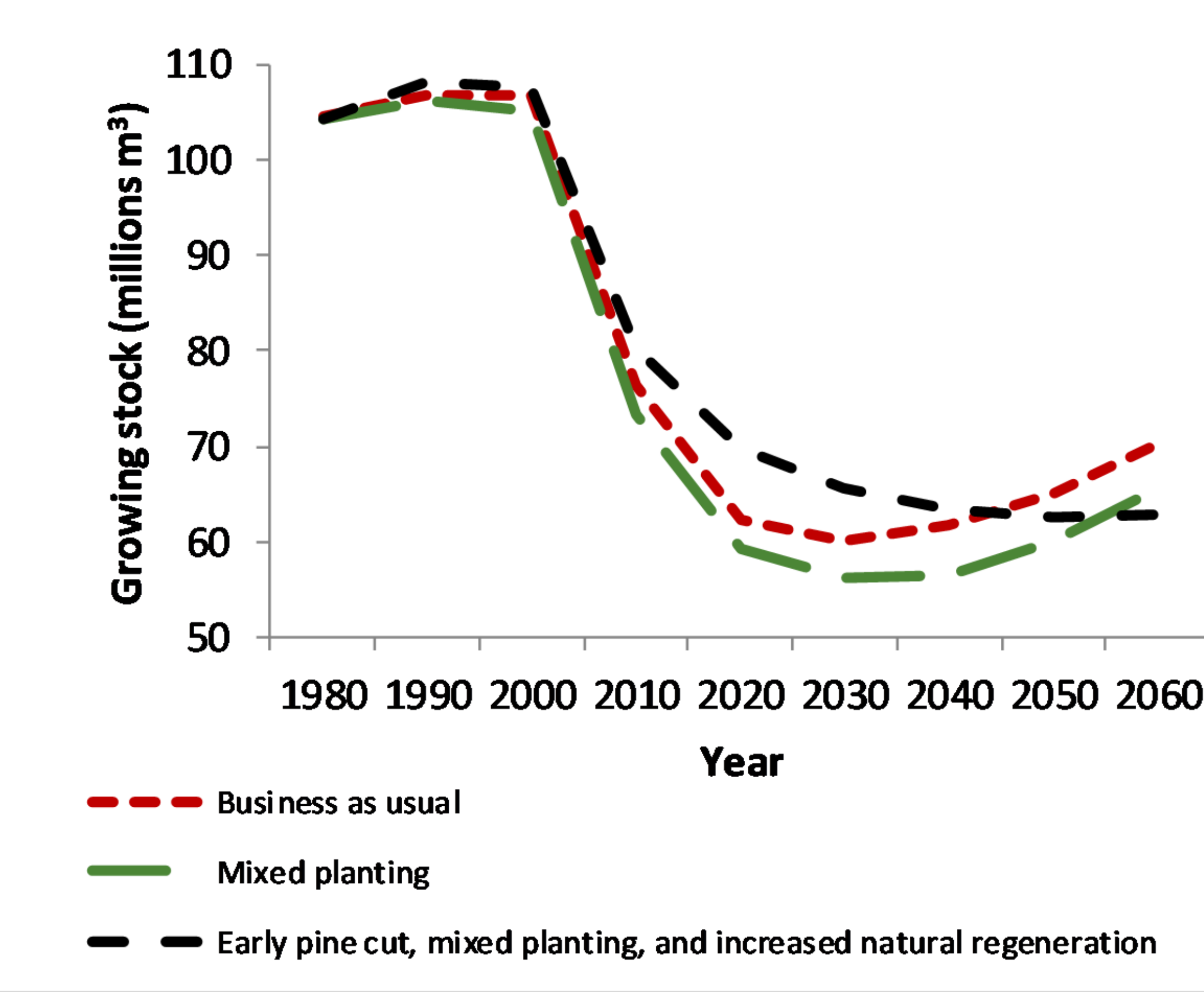


Figure 4. Volume harvested per year.

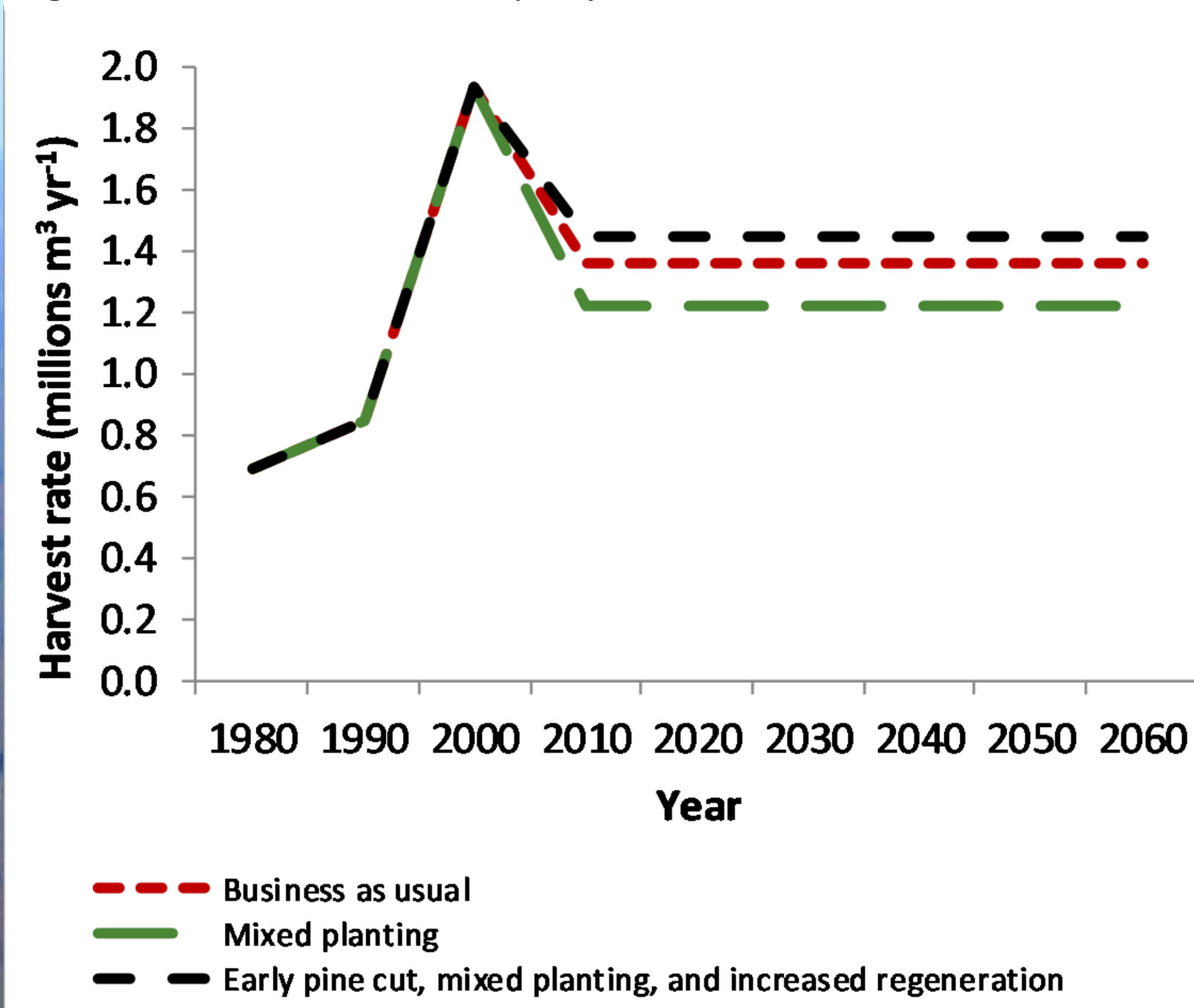


Table 2. Net present value by management strategy for 1980–2060 in millions of 2005 dollars.

Management strategy	Discount rate			
	0%	1%	3%	5%
Business as usual	1569	1061	574	372
Mixed planting	1524	1023	552	359
Early pine cut, mixed planting, more natural regeneration	1790	1181	611	380

Conclusions

- Diversifying stands and landscapes was effective at increasing survivorship and harvest post-beetle only under the most aggressive strategy.
- The Mixed planting strategy was insufficient to affect the beetle mortality after only 2 decades.
- Diversifying forest stands and landscapes was cost effective in light of a beetle outbreak.
- This indicates that the support for the insurance hypothesis depends on the forest characteristics and silviculture regimes interacting with the timing of forest health disturbances.

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Citation

- Dymond, C.C., S. Tedder, D. Spittlehouse, B. Raymer, K. Hopkins, K. McCallion, & J. Sandland 2014. Diversifying managed forests to increase resilience. Can. J. Forest Res. 44(10), 1196–1205.

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- Photo credit: Lorraine MacLauchlan

Application of the LANDIS-II PnET succession model to assess climate impacts on timber supply - a case study of the Bulkley TSA

Huapeng Chen, Sarah Beukema, Eric Gustafson, Dave Spittlehouse, Robbie Hember, Peter Ott, Yingbing Chen, Chuck Bulmer, Heather Klassen, Will MacKenzie, and David Stuart

What is the LANDIS-II?

- ◆ Forest Landscape Models (FLMs) are a class of spatially interactive and stochastic simulation models. LANDIS-II is a FLM model that has been extensively used to simulate landscape-scale forest dynamics.

Why the LANDIS-II?

- ◆ It simulates how ecological processes including succession, seed dispersal, disturbances (fire, harvest, insects, and windthrow etc.), and climate change interactively and explicitly spatially affect a forested landscape over time.

What is the PnET succession model?

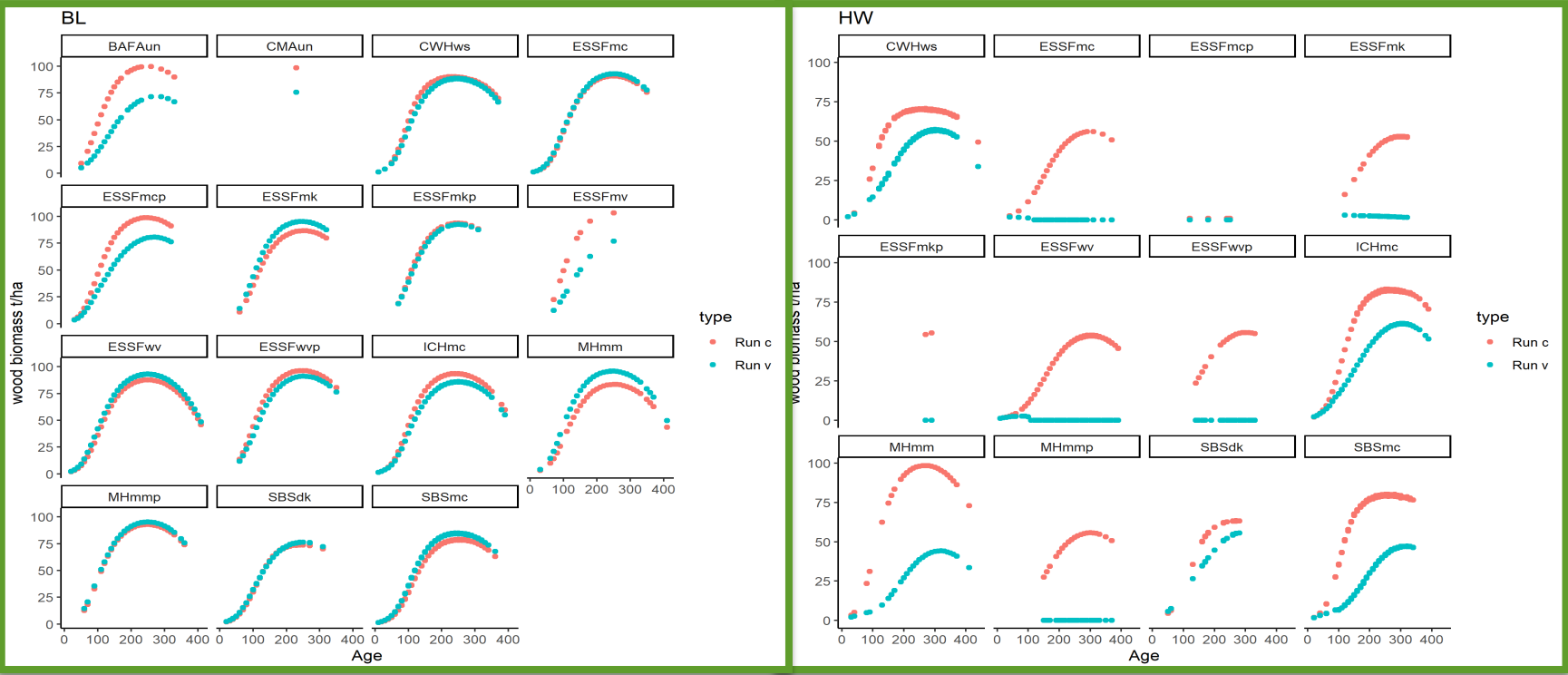
- ◆ The LANDIS-II PnET succession model, is a LANDIS-II extension that directly integrates output from a tree physiology model PnET II to simulate changes in competition for water and light that tree species undergo during succession.

Why the PnET?

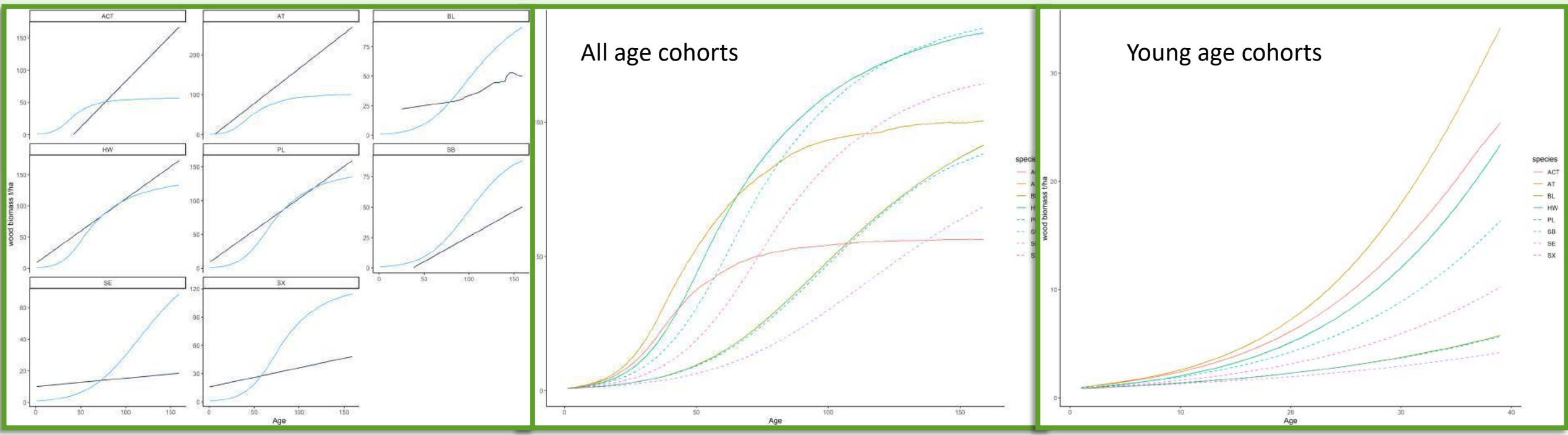
- ◆ It is a mechanistic model, simulating growth and competition for water and light dynamically and more explicitly linked to fundamental drivers that are changing, such as climate.
- ◆ It can dynamically calculate LAI and photosynthesis, thereby species establishment probabilities at each simulation time step as a function of water and radiation stress.
- ◆ Climate change impacts both variables and thus modelling of the changes over time will link directly to stand succession processes.
- ◆ It provides an opportunity to quantify changes in these processes and the resultant impact on timber supply, while linking them to the fundamental variables of climate change.

What we did?

- ◆ Developed a novel temperature-based approach to produce Photosynthetically Active Radiation (PAR) dataset (collaborated with Dave Spittlehouse, Robbie Hember, and Peter Ott).
- ◆ Produced historical and future climate datasets including the important input variable CO2.
- ◆ The future datasets were produced from the three climate models (CanESM2, CCSM4, and INM-CM4) under the three scenarios RCP 2.6, 4.5, and 8.5.
- ◆ Produced the soil rooting depth dataset (collaborated with Chuck Bulmer, Heather Klassen, and Will MacKenzie).
- ◆ Developed the automation python tool to create the initial landscape and ecoregion used for starting the simulation of model.
- ◆ Developed a novel calibration approach.
- ◆ Sensitivity analysis.
- ◆ Setup the other LANDIS-II extensions including harvest, fire, and BDA (mountain pine beetle outbreak).
- ◆ A total of 82 full model runs.



Different response of species to climate in different ecoregions. BL: subalpine fir; HW: western hemlock. c: constant climate; v: varied historical climate.



Calibrated growth curves (blue) and the fit line from VRI data (black).

Calibrated growth curves with a model calibrated parameter set

What we observed?

- ◆ The PnET succession model is sensitive to the predicted temperature and moisture levels.
- ◆ Different tree species respond to climate change differently in different ecoregions under different climate models and scenarios, thereby biomass and harvest levels show different patterns on the landscape.

What is the delivered message?

- ◆ The LANDIS-II PnET succession model is a useful tool for looking at the impacts of climate change on forest stand succession, particularly through spatially interactive processes with disturbances.

What are implications to the timber supply modeling?

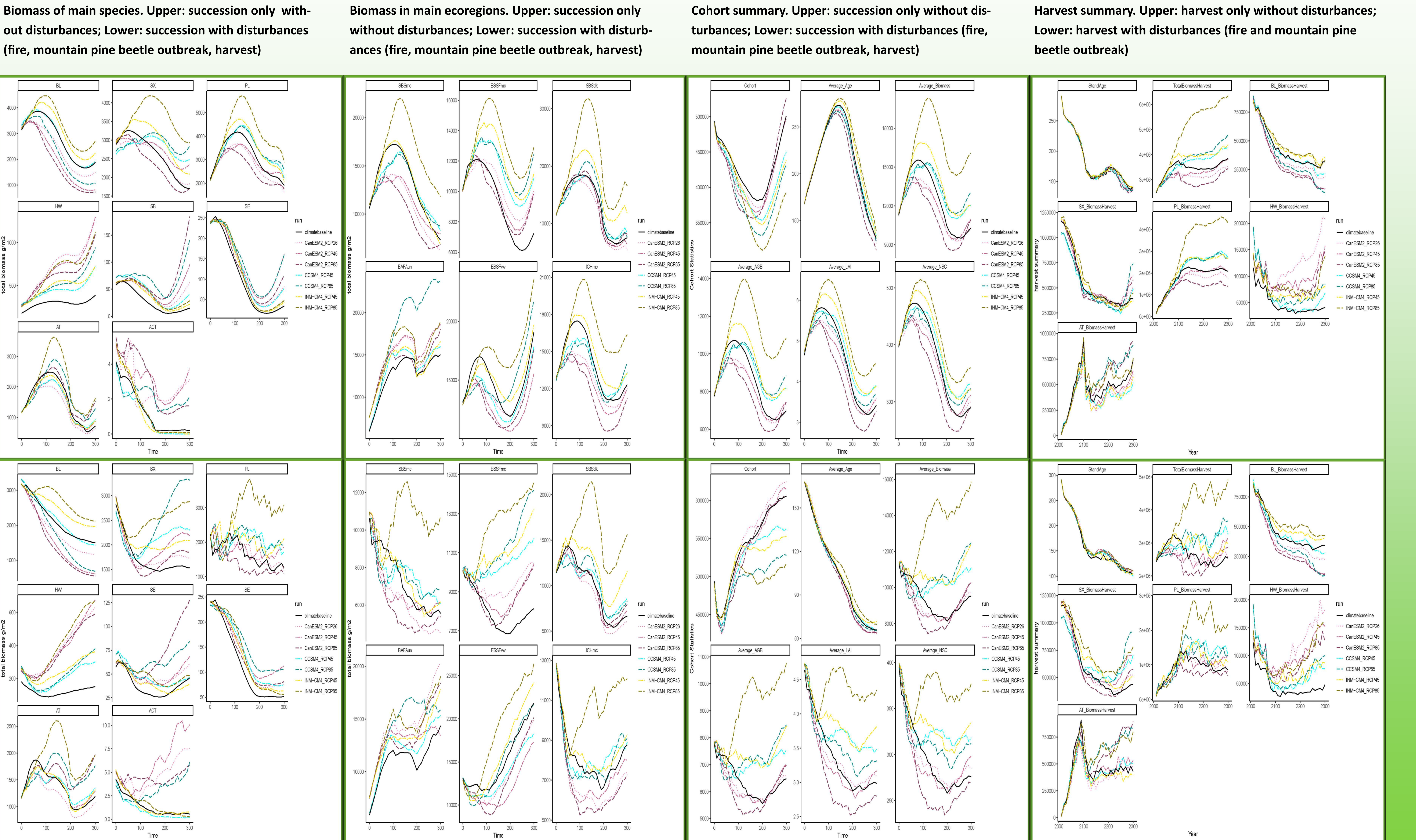
- ◆ The LANDIS-II PnET succession model can be applied to assess climate impacts on timber supply through a potential linkage with the current timber supply models.

What are challenges and caveats?

- ◆ The PnET succession model uses a single growth curve for a species across the entire landscape and assumes that the majority of difference in the growth is due to ecoregion level differences. There are also some differences due to competition on a site. However, it cannot distinguish between different site series within an ecoregion or micro-site issues.
- ◆ It is difficult to judge if the calibration done so far is good enough.

What is the next?

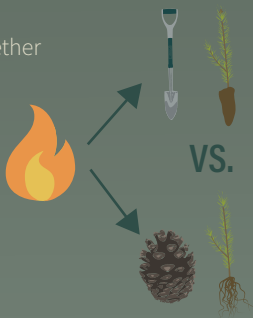
- ◆ Explore the potential linkage of the PnET succession model outputs to the timber supply model (s) in more practical ways.



Post-Fire Carbon Recovery

Many forests are adapted to wildfire, but climate change has increased fire size, frequency, and severity, making it more difficult for new trees to establish afterwards. This could impact the ability of fire-affected forests to serve as a net carbon “sink”, as slow regeneration may extend the time needed to reach a state where they can absorb and store carbon.

This study examines whether post-fire tree planting, a common management action, results in greater total ecosystem carbon over time compared to stands that are left to regenerate naturally.



INFOGRAPHIC BY FUSE CONSULTING LTD.

To measure these impacts, we:

- Determined carbon recovery and stores in 21 wildfires across central interior B.C. from the early 1960s to 2015.
- Measured the amount of carbon stored above and belowground to determine how carbon storage changes over time post planting.



Tree planting did not increase total ecosystem carbon over time.

If dead standing and downed trees are removed from burned sites (i.e., through site preparation activities), tree planting does not compensate for the loss of stored carbon in the dead wood over time.



To ensure regenerating forests in B.C.'s central interior can serve as carbon sinks, legacy carbon stores, like dead wood, should be preserved, or forests should be left to regenerate naturally.


Bulkley Valley
Research Centre

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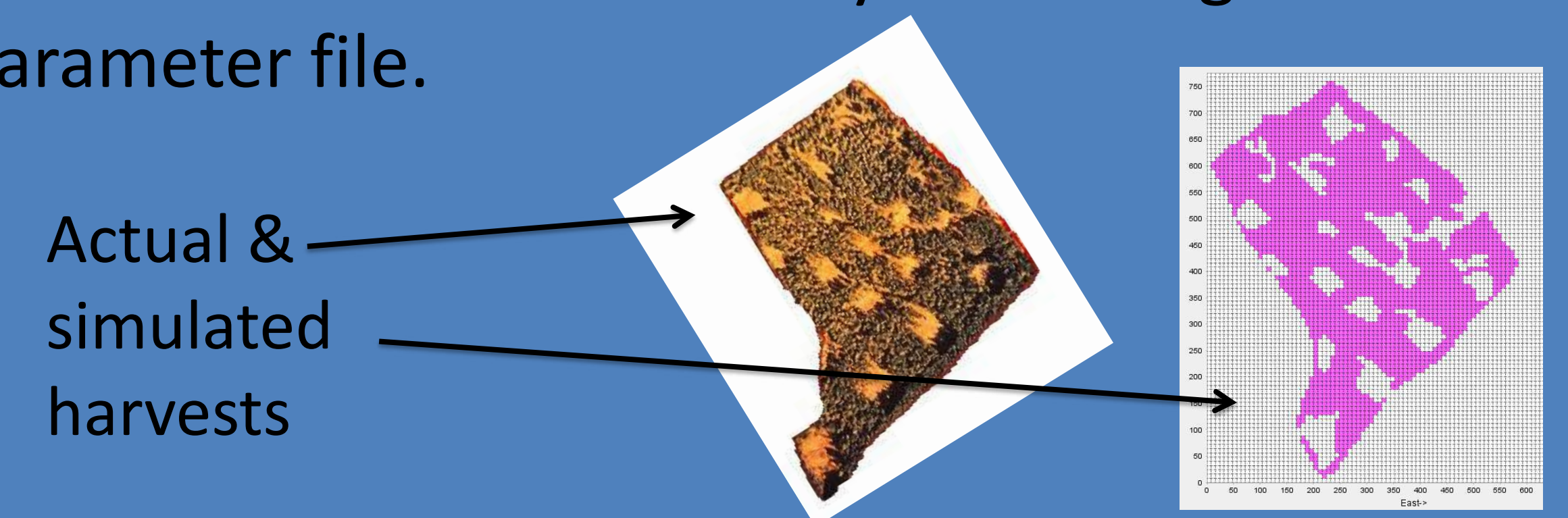
We gratefully acknowledge the financial support of the Government of Canada through the Low Carbon Economy Leadership Fund and Province of B.C. through the Ministry of Forests, Lands, Natural Resource Operations and Rural Development.

SORTIE-ND for Northern BC

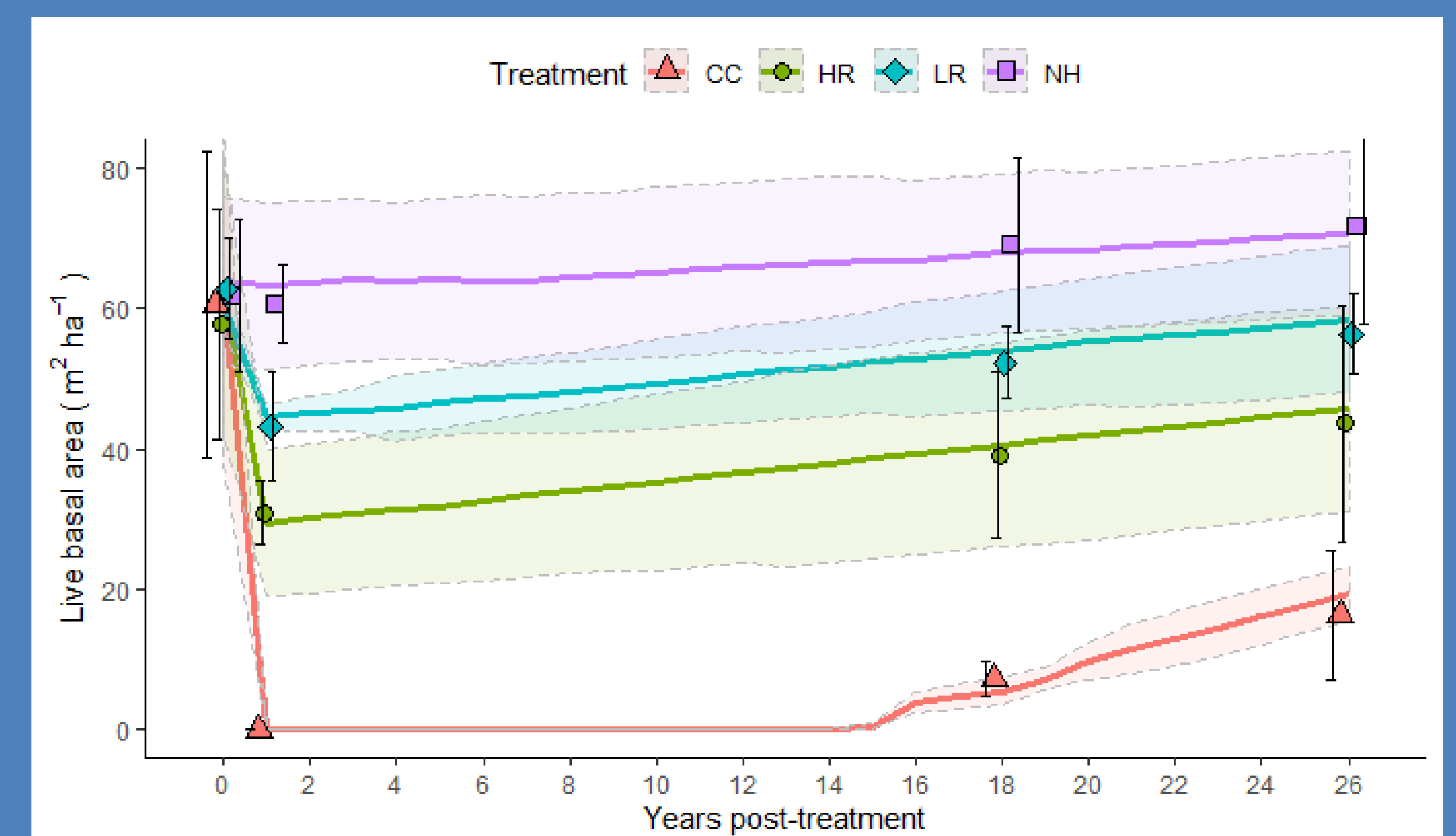


Development and evaluation of SORTIE-ND for use in northern BC SBS and ICH ecosystems has accelerated in recent years. Long-term datasets from two of the province's silvicultural systems studies, Summit Lake and Date Creek, have allowed comparison of SORTIE simulations and empirical data.

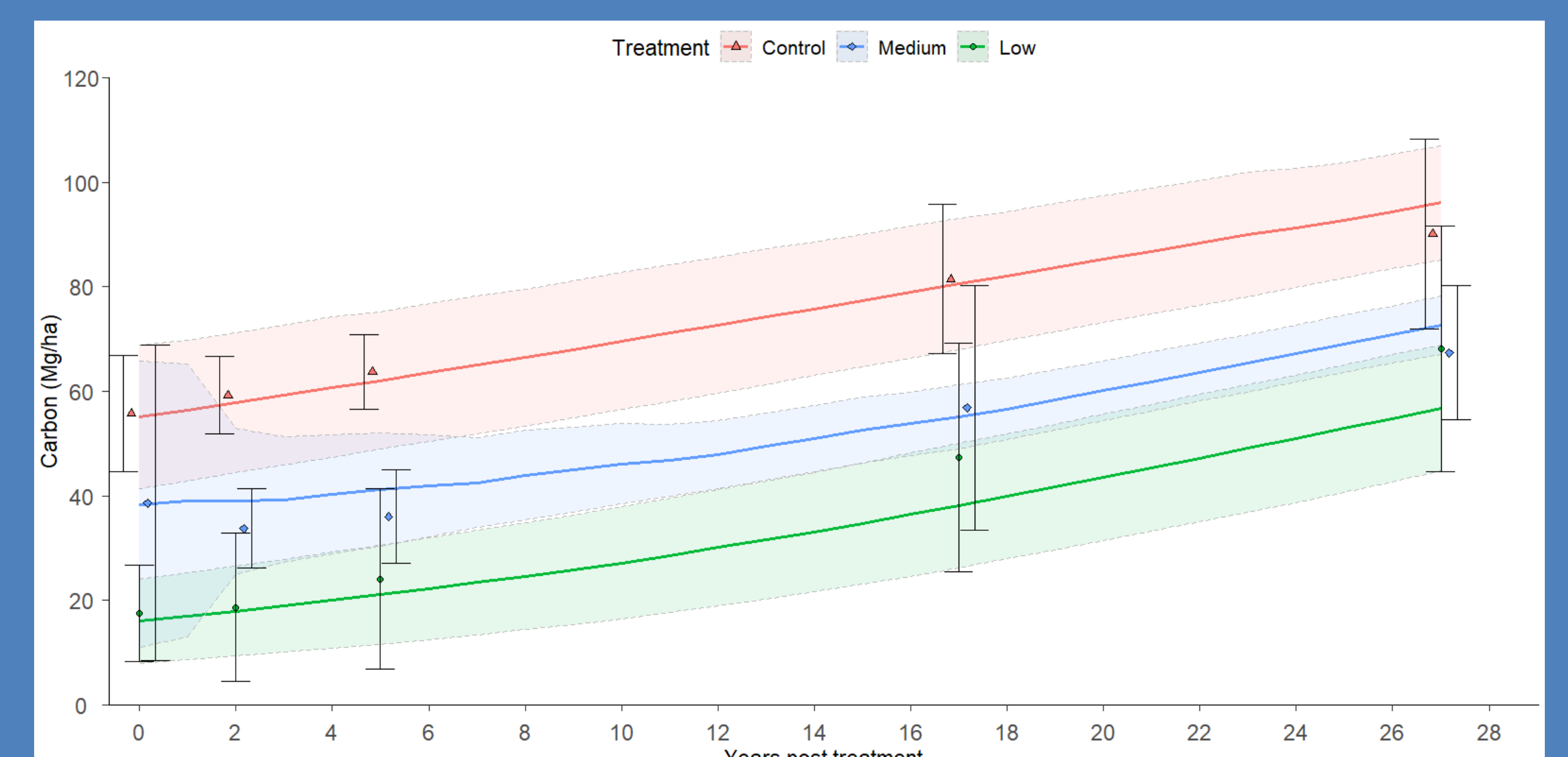
The 16 treatment units of the **Date Creek** research forest were simulated in SORTIE with the same spatial configuration of the actual harvest and run for 26 years using the ICH parameter file.



SORTIE simulations predicted live basal area means and confidence intervals of the four treatments (CC-clearcut, HR- heavy removal, LR- light removal and NH- no harvest) which were very close to the actual values.



The 19 treatment units from **Summit Lake** were simulated in SORTIE for 27 years post-harvest using the SBS-05/06 parameter file. SORTIE simulations predicted the live carbon pool of the control and medium basal area treatment quite well and underestimated carbon in the low basal area treatment.



Individual field studies conducted over the past 20 years in northern BC have contributed to parameterizing SORTIE for SBS and ICH ecosystems. This model was originally intended to be a tool to help researchers understand what mixed-species and partially-cut forests would look like 50 years after harvest. Now we can evaluate its performance against long-term field data, gain confidence in its projections, and determine where further refinement is needed. Applications for SORTIE in BC have expanded and now include carbon modelling, simulating stand responses to natural disturbances such as bark beetles, and predicting wildlife habitat features after different harvest scenarios.



www.sortie-nd.org
forests-bvcentre.ca/sortie

Funded in part by:
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To Salvage or Not to Salvage:

Assessing the Biodiversity Conservation Potential of Residual Forests Following Spruce Beetle Attack



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Ministry of Forests,
Lands & Natural
Resource Operations

BACKGROUND

- **The Spruce Beetle** (*Dendroctonus rufipennis*) is a species of **bark beetle native to Canada**. It is the most damaging pest of mature hybrid white spruce in British Columbia.
- **Spruce Beetle Key Facts:**
- Estimated **1.3 million hectares** of forest, much of which in the Prince George area during the past six years (~ **354,000 hectares of damage in the Omineca Region**).
- Status updated from **endemic** (just part of the forest) to an **outbreak** with no end in sight, since 2014.



SOME RESEARCH PRIORITIES

- **Forest renewal:** *What are the prospects of natural regeneration following spruce beetle outbreaks?* Natural regeneration of white spruce has been a challenge in many areas in the Province.
- **Biodiversity:** *How do beetle-killed stands compare to an undisturbed old-growth forest in terms of biodiversity conservation potential?* Retention of old-growth forests is a top conservation priority in the Province for sustaining biodiversity.

LOCAL SPRUCE BEETLE INITIATIVE

- The **Spruce Beetle Ecosystem Monitoring (SBEM) Project** is undertaken to provide baseline data on initial forest conditions following spruce beetle attack. Initiated by Bruce Rogers in May 2020.
- The SBEM project focuses on **moister, wetter, cooler Sub-Boreal Spruce (SBS) ecosystems north of Prince George** that have been recently attacked by spruce beetle.
- **Field data collection is ongoing.** Twenty (20) permanent sample plots have so far been established and sampled using standard procedures.

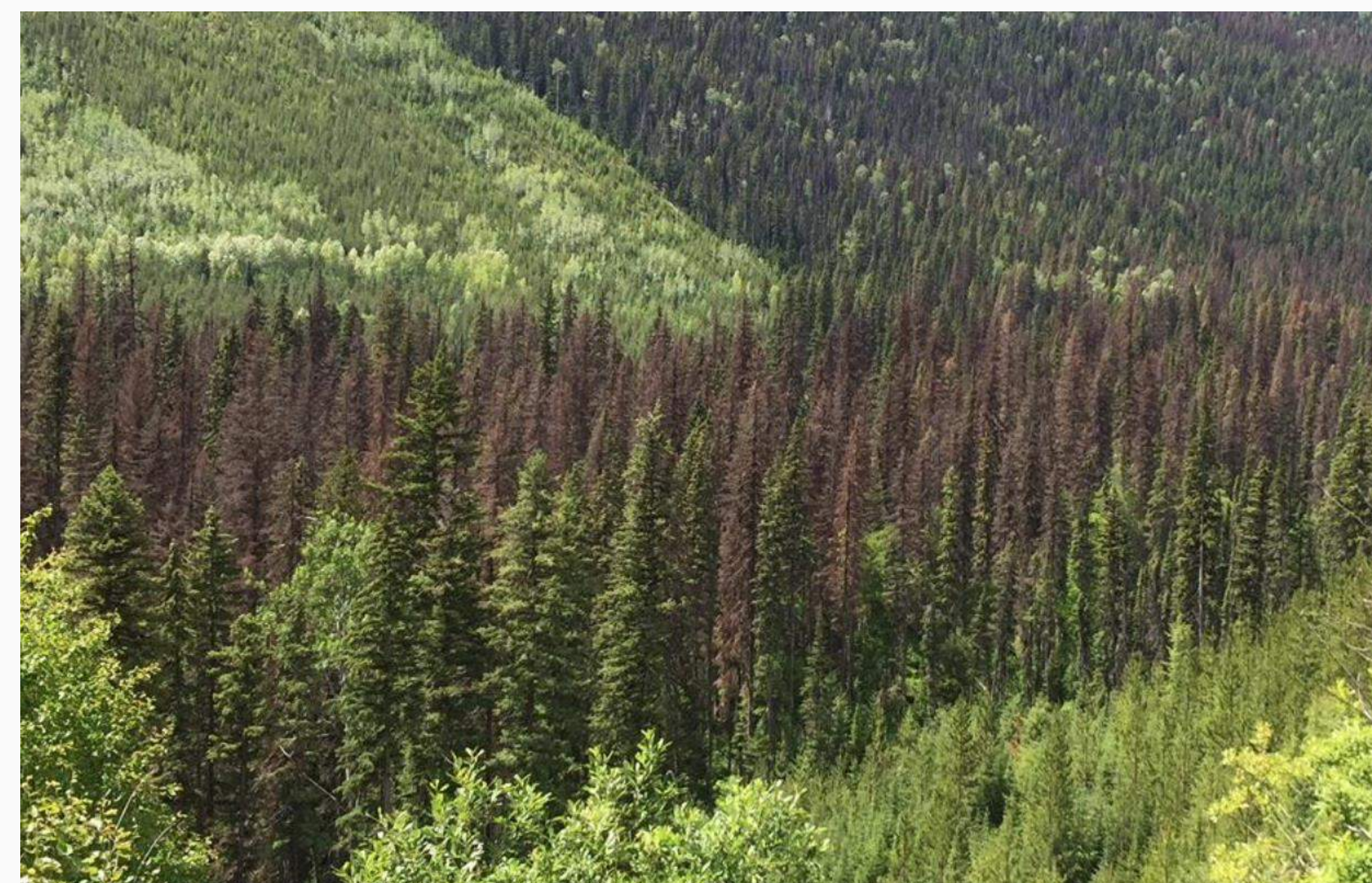


Fig. 1. Aerial view of spruce beetle infestation. Credit: nclga.ca

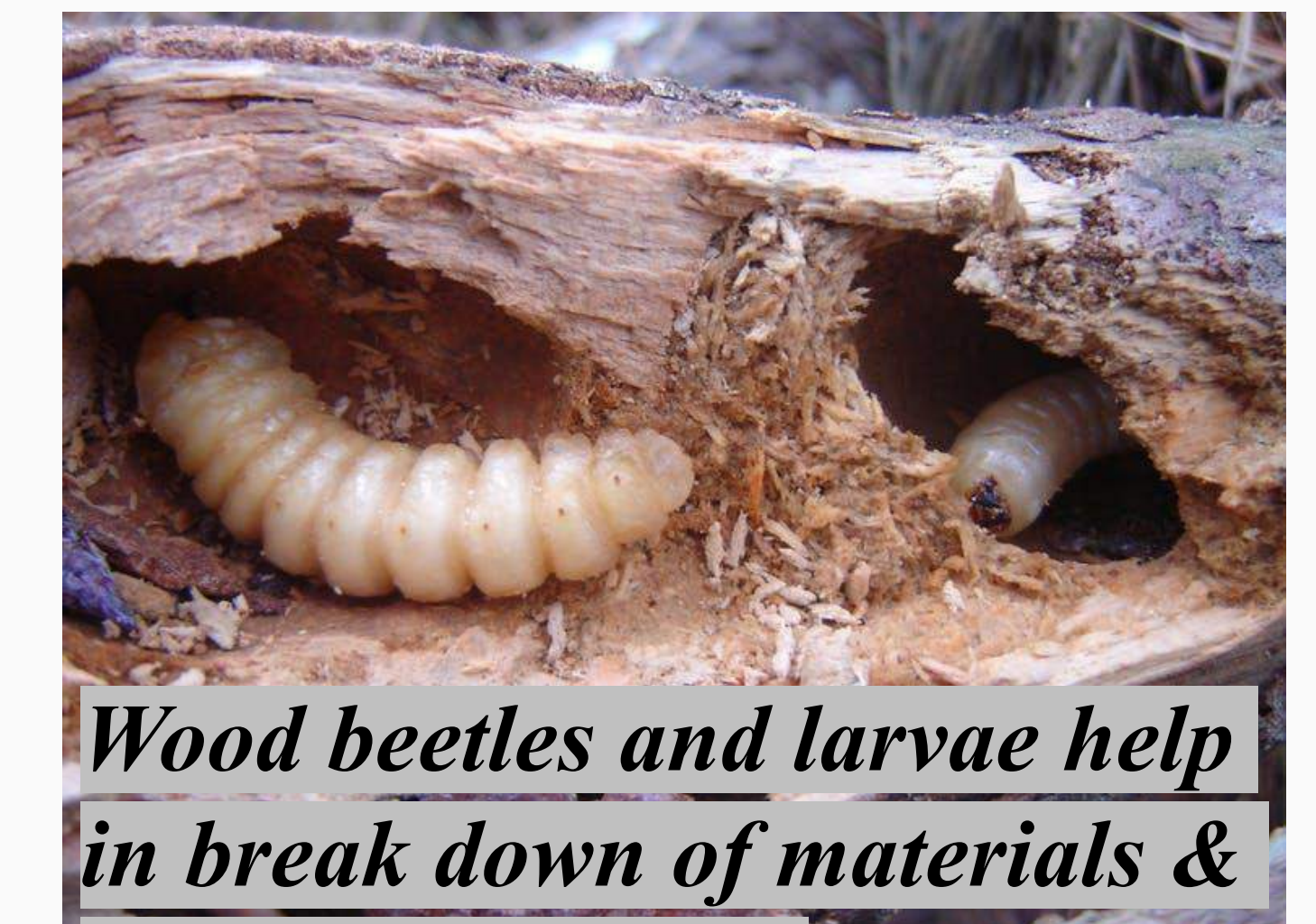
Many uses of “wildlife trees”



Dead trees can support cavity nesters and small mammals



Bear den



Wood beetles and larvae help in break down of materials & release of nutrient



Shelter and runway for reptiles & amphibians



Decomposing downed wood support a great diversity of fungi, lichens, and mosses.



Increased understory plant diversity

Photos sourced from
Wikimedia Commons

Salvage Logging Considerations

- Salvage logging is practiced in hard-hit areas to **reduce the beetle's spread** and **maximize timber recovery** before the wood quality deteriorates.
- Harvest operations provide **opportunities to replant** where natural regeneration may not have otherwise been achieved.
- However, salvage logging following spruce-beetle outbreaks are **often criticized for advancing clearcuts** that imperil biodiversity in many sensitive and rare old-growth spruce forests. **Clearcut harvesting has low social acceptability.**

Ecological Considerations

- **Opportunities for forest renewal:** Spruce beetles are normally relegated to weakened and dying trees. Healthy trees are well defended.
- **Unique forest structure and habitat conditions** post-spruce beetle outbreak (e.g., abundance of deadwood and ‘wildlife trees’) may **promote wildlife and forest biodiversity.**
- **Ecological function is maintained** following attack. However, evidence of resilience and survival of residual forests following spruce-beetle attack is inconclusive, necessitating the need for long-term research.

CONCLUSION & RECOMMENDATION

- **Sustainable management need to balance economic, social, and ecological priorities** in a manner that maintains the functioning and productivity of managed forests.
- It is anticipated that the **biodiversity conservation potential residual beetle-killed stands may rival that of an undisturbed old-growth forest.** If so, beetle-killed stands may warrant similar protection as old-growth forests. We will need to **increase forest set-asides and prioritize some affected and recovering forests** to achieve wildlife and biodiversity conservation targets.



We want to lead discussions and engage in conversations about important research needs and priorities of government, industry, and other stakeholders.
A vital part of that is keeping up conversations with you.

We Would Like to Hear from You on this Topic. Please Take Part in Our Survey.



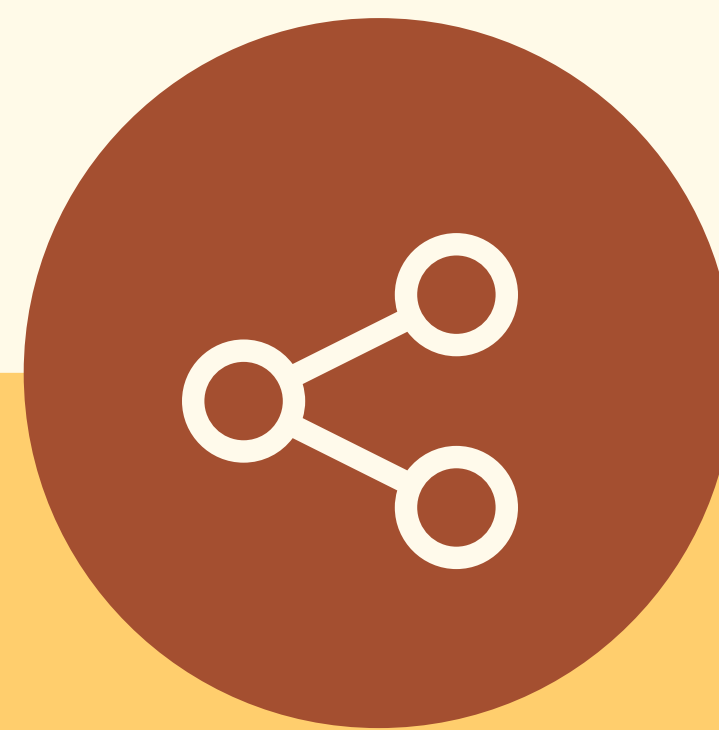


SCIENCE IN THE PUBLIC INTEREST

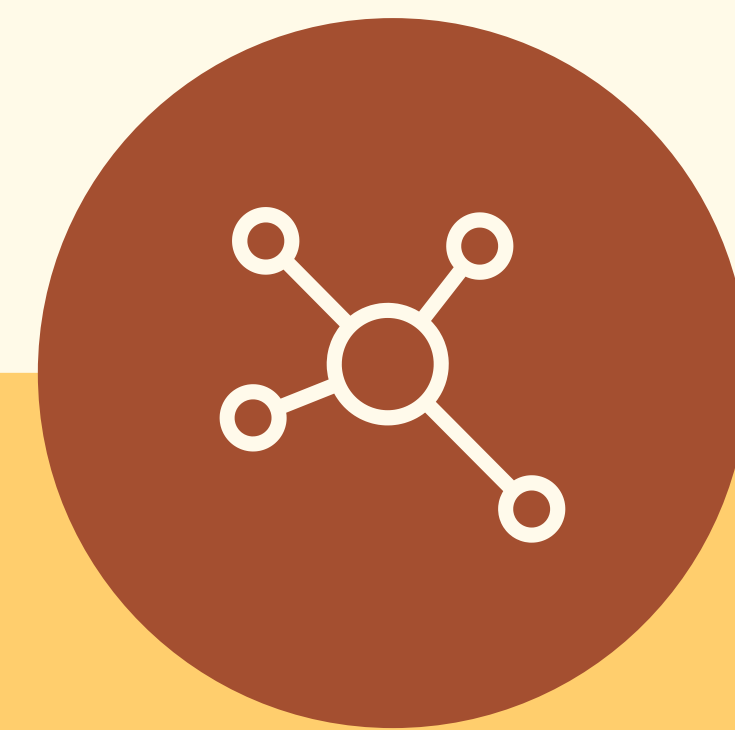
WHAT WE DO



Undertake, facilitate, and promote high-quality interdisciplinary research and monitoring relating to natural and community resources.



Disseminate research, data and knowledge through seminars, workshops, conferences and other extension opportunities, ensuring access by all.



Connect researchers with each other and the community, encouraging collaboration to better address the stewardship of natural and community resources.

RESEARCH SUSTAINABILITY AND STEWARDSHIP

The Centre focuses its research on natural resources sustainability throughout the northwest and beyond: the sustainability of ecosystems, cultures and communities. Our research initiatives are often multi-year and involve collaboration among a range of groups involved in natural resource management including government, First Nations, academic institutions and conservation organizations. Along with objective research, the Centre provides a single point of contact for a diversity of perspectives to meet and engage.

COMMUNITY NEXUS

The Centre serves to connect researchers with each other and the greater community through networking, learning, and research opportunities. We also support community engagement on natural resource management issues and decision-making through the research and distribution of data that promotes long-term community sustainability. Supporting researchers in NW BC builds strong scientific capacity and creates learning and employment opportunities for graduate students and researchers.

PROJECT ADMINISTRATION

As a registered not-for-profit society, the Centre acts as a conduit for researchers to apply for funding. The Centre provides administrative, financial and budgeting support to researchers and approved projects. Creating collaborative opportunities enables access to funding that might not otherwise be available to researchers and can bring together funding from multiple sources to support long term projects. The Centre also forms and administers trusts for research and monitoring, such as the Skeena Knowledge Trust and the Morice Watershed Monitoring Trust.

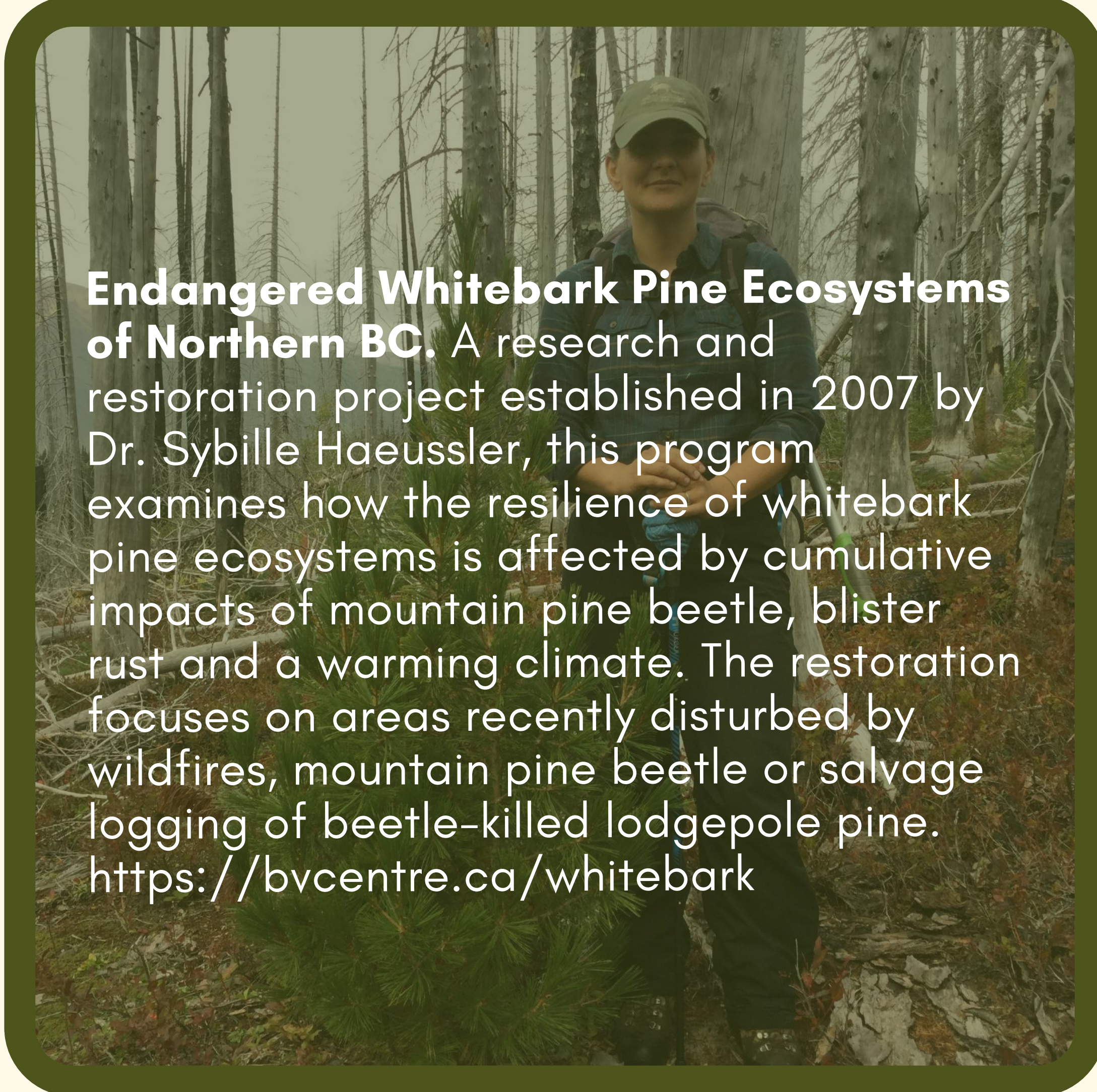
KNOWLEDGE HUB

The Centre creates learning and extension opportunities for members and the community at large through workshops, conferences, seminar series, and networking events. As an independent body, the Centre provides a neutral place for a diversity of perspectives to come together and share research and ideas addressing pressing challenges.

RESEARCH CENTRE PROGRAM HIGHLIGHTS



Forest Stand Dynamics Research and Modeling. This research program is a long-term collaboration with the Ministry of Forests. The FSD program studies forests to understand how disturbance and forest management impact function and dynamics, ecological resilience, and ecosystem values and services with field-based studies and SORTIE-ND – an individual-tree spatially-explicit model of forest dynamics. <https://forests-bvcentre.ca/>



Endangered Whitebark Pine Ecosystems of Northern BC. A research and restoration project established in 2007 by Dr. Sybille Haeussler, this program examines how the resilience of whitebark pine ecosystems is affected by cumulative impacts of mountain pine beetle, blister rust and a warming climate. The restoration focuses on areas recently disturbed by wildfires, mountain pine beetle or salvage logging of beetle-killed lodgepole pine. <https://bvcentre.ca/whitebark>



Wildfire Resiliency Research Initiative. Wildfire research is focused on: 1) developing a better understanding of historical fire regimes and past forest management practices and how they relate to the current forest/fuel structure and wildfire fire behaviour; 2) studying post-wildfire reforestation and carbon dynamics; and 3) understanding the effects of fire on ecosystem components, in particular on plants of importance to First Nations, wildlife, and endangered species.