FINAL REPORT

Study to advance harvest system and silviculture practices for improved woodland caribou and fibre outcomes

Prepared for
Alberta Regional Caribou Knowledge Partnership

University of Northern British Columbia[1] and fRI Research Caribou Program[2]

September 13, 2024

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Executive Summary

Woodland caribou (*Rangifer tarandus caribou*) are experiencing population declines largely because of landscape changes that convert mature forest to early seral forest. Conservation initiatives for caribou will need to include forest practices that expedite the recovery of functional caribou habitat. We evaluated differences in the ecological outcomes of fire and forest harvest for woodland caribou and other forest values across an extensive area (88,900 km^2) of Alberta. In the summers of 2021 and 2022, we collected field data from 251 timber harvested, 264 burned stands (0–40 years since disturbance), and 256 older forest stands used by caribou (> 40 years since disturbance) distributed across 5 Natural Subregions (NSR). Field data included stand characteristics that reflected timber supply (e.g., basal area, stems per hectare (SPH)), understory and ground conditions (e.g., coarse woody debris (CWD), soil depth), and abundance of forage important for caribou (e.g., terrestrial lichens). The percentage and basal area of deciduous trees was greatest in the Central Mixedwood NSR and caribou forage was the least abundant in the Central Mixedwood (Chapter 2). We did not detect other significant differences in stand characteristics for caribou use sites among NSRs, which may be explained by the broad range of stand ages (41-220 years) used by caribou. Timber supply increased more rapidly following timber harvest compared to wildfire; a pattern that was largely consistent across NSRs (Chapter 3). CWD and coniferous saplings were more abundant in early post-wildfire sites, but with increased time since disturbance abundance decreased and matched values in the timber harvested and caribou use sites. Abundance of caribou lichens was greatest in caribou use sites and generally low following both timber harvest and wildfire but became more abundant in wildfire sites after 10 years post-disturbance. We found that relationships between stand characteristics and forage groups varied among site type. For example, canopy cover was positively associated with moose saplings in cutblocks but had no association with moose saplings in wildfire sites. Also, some stand characteristics could have positive impacts on one forage group and negative impacts on others. For example, deciduous basal area in cutblocks was positively associated with moose shrubs and negatively associated with caribou lichens. In Chapter 4, we used a growth-and-yield forest model to project future stand development and characterize the impact of harvest and wildfire on future timber supply and availability of the forage groups. We compared those projected values to timber supply and availability of forage observed in caribou use sites. We found that projections for timber supply (e.g., basal area) generally reached greater values in cutblock sites compared to caribou use sites in as early as 10 projected years. The projected trajectory of wildlife forage greatly varied among NSR and disturbance type. We found that projected abundance of caribou lichens in cutblock and wildfire sites could reflect values in stands used by caribou as early as 40 projected years. Moose shrubs and bear shrubs were projected to reach a greater abundance in most cutblock and wildfire sites when compared to caribou use sites, irrespective of time since disturbance. Overall, our data and models suggest that initial tree densities of 1000–2999 SPH in cutblocks resulted in the greatest basal area of all tree types and lower deciduous basal area. Reducing deciduous basal area could also have negative impacts on moose and bear forage and positive impacts on caribou forage. As caribou use sites generally had lower canopy cover and SPH than cutblocks, targeted stand thinning or planting densities to achieve final metrics similar to those of caribou use sites in the same NSR, could reduce the differences between cutblocks and stands that caribou use. In this report, we described the fine-scale forest attributes that characterize caribou habitat. Furthermore, we have described where and when timber harvest differs from wildfire and areas used by

caribou for multiple stand characteristics in multiple NSRs across Alberta. We described the associations between stand characteristics and availability of forage for caribou, moose, and bear. Finally, we provided future projections of stand characteristics and forage for timber harvested and burned stands with comparisons to the stands used by caribou.

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TABLE OF CONTENTS

List of Figures

LIST OF TABLES

1. Background

1.1 Introduction

Declines of woodland caribou populations are caused by landscape changes that convert mature forests to early seral stands, resulting in habitat loss for caribou, abundant forage for primary prey species, and increased predation risk for caribou via apparent competition (DeCesare et al. 2010, Festa-Bianchet et al. 2011, Johnson et al. 2020). Long-term solutions for caribou conservation will require habitat restoration and adaptive management (Johnson et al. 2019, Serrouya et al. 2020, Nagy-Reis et al. 2021, DeMars et al. 2023). Within managed forests, current reforestation strategies as well as future timber harvesting systems and silviculture practices could influence the timeline and effectiveness of re-establishing functional caribou habitat (Courtois et al. 2008, Nadeau Fortin et al. 2016, Vitt et al. 2019, McKay and Finnegan 2022). Differences in forest stand characteristics and habitat attributes between natural disturbances and harvest disturbances may also influence availability of current and future woodland caribou habitat (Rudolph et al. 2019). Adaptive forest management has the potential to contribute towards caribou recovery and could help maintain caribou across the boreal forest in the uncertain face of climate change (Leblond et al. 2022).

The purpose of this project is to provide the forest sector with information that could be used to implement forest management strategies that benefit caribou across Alberta. Specifically, we evaluated the fine-scale attributes of forest stands used by caribou and compared those attributes to stands disturbed by wildfire and harvest. Specific objectives are outlined in section 1.4.

1.2 Study Area

The study area was within the homelands of the Aseniwuche Winewak, Beaver, Beaver Lake Cree, Big Stone Cree, Dakeł Keyoh, Den Tha', Dënéndeh, Ktunaxa ʔamakʔis, Lheidli T'enneh, Nehiyawak, Michif Piyii, Mountain Mètis, Secwepemcúl'ecw, Stoney, Tsuu T'ina, and Woodland Cree peoples (best available knowledge from native-land.ca). The study area was 88,900km^2 in size and included three regions comprising of north-western, north-eastern, and west-central, Alberta, Canada (Figure 1.1). These regions incorporated the ranges of nine caribou populations: north-western—Chinchaga (boreal population); north-eastern—East Side Athabasca, West Side Athabasca, Nipisi, and Red Earth (boreal populations); west-central—Little Smoky (boreal population), A La Peche, Narraway, and Redrock Prairie Creek (central mountain populations; COSEWIC 2014). Boreal and central mountain caribou are listed as Threatened under the federal Species at Risk Act (SARA) and the provincial Alberta Wildlife Act

(Government of Alberta 2024), central mountain caribou are also listed as Endangered by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC 2014).

Natural Subregions (NSR) within the study area include Central Mixedwood, Lower and Upper Foothills, and Lower and Upper Boreal Highlands (Figure 1.1; Natural Regions Committee 2006). The study area included 5 of 9 NSRs where caribou currently occur in Alberta (did not include Alpine, Subalpine, Boreal Subarctic, Northern Mixedwood). Dominant tree species in the study area are lodgepole pine (*Pinus contorta*), jack pine (*Pinus banksiana*), white spruce (*Picea glauca*), black spruce (*Picea mariana*), trembling aspen (*Populus tremuloides*), tamarack (*Larix laricina*), and paper birch (*Betula papyrifera*). Shrubs and forbs include willows (*Salix* spp.), bog birch (*Betula glandulosum*), alders (*Alnus* spp.), blueberries (*Vaccinium* spp.), Labrador tea (*Rhododendron groenlandicum*), and horsetails (*Equisetum* spp.). Ungulates in the study area include caribou, moose (*Alces americanus*), elk (*Cervus canadensis*), white-tailed deer (*Odocoileus virginianus*), mule deer (*Odocoileus hemionus*), bighorn sheep (*Ovis canadensis*), and mountain goats (*Oreamnos americanus*). Large carnivores include wolves (*Canis lupus*), coyotes (*Canis latrans*), grizzly bears (*Ursus arctos*), black bears (*U. americanus*), cougars (*Puma concolor*), Canada lynx (*Lynx canadensis*), and wolverines (*Gulo gulo*).

Anthropogenic disturbances in the study area include oil and gas extraction, and timber harvest. The study area overlaps with eight Forest Management Agreements (Alberta-Pacific Forest Industries Ltd., ANC Timber Ltd., Canadian Forest Products Ltd., Manning Forest Products Ltd., Mercer International Ltd., Tolko Industries Ltd., West Fraser Mills Ltd., and Weyerhaeuser Company Ltd.) and land harvested by Foothills Forest Products. Natural disturbance in the study area includes mountain pine beetle (*Dendroctonus ponderosae*), windthrow, and wildfire.

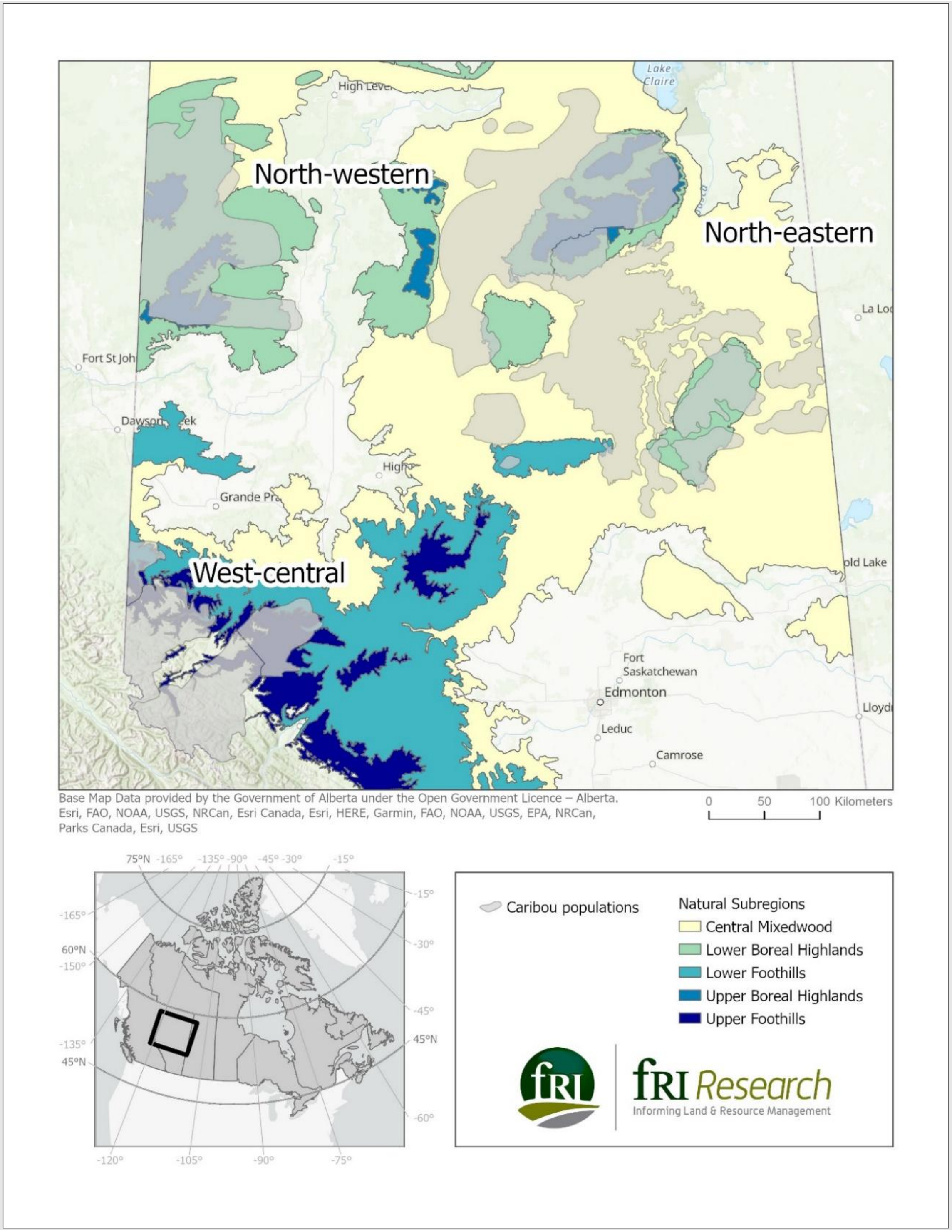

Figure 1.1. Study area in Alberta, Canada, used to assess differences in forest characteristics and habitat for woodland caribou within harvested and burned stands, and stands caribou use between 2021 and 2022. Caribou population ranges and natural subregions are also shown.

1.3. Field data

We identified field sampling strata and field methods in collaboration with the ARCKP project committee. Because ARCKP members were interested in the impacts of silviculture treatments on forest stands, provisional field sampling strata (distributed 23rd April 2021) included NSR, ecosite, age of disturbance, metrics of silviculture treatments (whether herbicide were applied, method of herbicide application [aerial/ground]), as well as burn intensity. Depending on the strata combinations, this resulted in between 72 and 158 strata (Appendix A). ARCKP member feedback received (May 2021) was to focus on the NSR/ecosite/age strata combination (Appendix A: Option 1) and determine whether there was enough variation within the dataset to also include silviculture treatments at the analysis stage. Final strata and field methods were finalised with the ARCKP project committee (June 1 and 12th 2021), and additional opportunities for feedback and strata modifications were provided before year two of data collection (two meetings held in January 2022).

1.3.1. Generating sampling sites

We used a random stratified design to select sites for field data collection that had been disturbed (harvested or burned) and sites that were used by caribou, hereafter ‘cutblock’, ‘wildfire’, and ‘caribou use’ sites (Figure 1.2). For cutblock and wildfire sites, we used provincial forest inventory and wildfire data provided by the Government of Alberta. Cutblock sites were clearcut harvested, and wildfire sites experienced large-scale wildfires (>94% of area burned, >200 ha burned area). We clipped these data to the three regions (north-western, north-eastern, west-central), and then partitioned data by NSR and age since disturbance (grouped into 10-year intervals: 0–10, 11–20, 21–30, 31–40). We used a random number generator to identify candidate sites for field data collection within each stratum (Table 1.1).

For caribou use sites, we used GPS location data (2019–2022) collected by the Government of Alberta as part of long-term provincial monitoring. Caribou were captured during fall or winter using helicopter net-gun (Government of Alberta Wildlife Caribou Committee Class Protocol #8) and fitted with GPS collars with 1-hr fix schedules. First, we partitioned GPS location data into previously defined seasons for each population (Table 1.2; MacNearney et al. 2016, Pigeon et al. 2016, Konkolics et al. 2021) and created a point density layer (500-m resolution) for each population and season. Then, we partitioned population-season density layers into three density quantiles (low, medium, high), and attributed each caribou GPS location as being within a low, medium, or high density of use area. We used a random number generator to select candidate caribou use sites (actual GPS locations) for field data selection, stratified by NSR and season. If there were insufficient high-density locations for a NSR we used locations that fell within medium density of use areas. We did not draw sample sites from low-density areas. All caribou use sites were greater than 40 years since disturbance.

To reduce spatial autocorrelation among sites, we further subset randomly selected candidate sites to ensure that all sampling sites were >500m from other sites within the same strata. To reduce the impact of edge effects on field data, we also ensured that all sampling sites were >20m from the strata edge. Most sites were road accessible (< 3km from the nearest road), except for sites in the north-eastern region, which were only accessible via helicopter. If field crews encountered stratum mismatches (e.g., a recently harvested caribou use site), they moved the sampling plot by increments of 20m in a randomly selected cardinal direction until the plot fell within the target strata. Across two summers (2021, 2022) the field crews collected field data from 251 cutblock, 264 wildfire, and 256 caribou use sites (Table 1.1, 1.3, 1.4; Figures 1.2–1.4).

Table 1.1. Number of sampling sites where field data were collected in the summers of 2021 and 2022 within each cutblock and fire age strata used to assess differences among harvested and burned stands, and stands used by caribou, in Alberta, Canada.

Age	Cutblock	Wildfire
0-10y	65	94
11-20y	75	61
21-30y	69	55
31-40y	42	54

Table 1.2. Dates used to partition caribou use samplings sites into seasons for field data collection in the summers of 2021 and 2022 to assess differences among harvested and burned stands, and stands used by caribou, in Alberta, Canada.

Region	**West-central**				**North-western**	**North-eastern**
Season	**A La Peche**	**Narraway**	**RPC**	**Little Smoky**	**Chinchaga**	**Combined populations**
Spring	Apr 11 - Jun 2	May 5 - Jun 19	May 10 - Jun 19	Apr 11 - Jun 2	Apr 8 - Jun 6	Apr 15 - Jun 30*
Summer	Jun 3 - Sep 29	Jun 20 - Oct 7	Jun 20 - Oct 7	Jun 3 - Sep 19	Jun 7 - Sep 23	Jul 1 - Oct 31
Fall	Sep 30 - Nov 27	Oct 8 - Nov 28	Oct 8 - Nov 28	Sep 20 - Dec 3	Sep 24 - Nov 5	-
Early Winter	Nov 28 - Jan 23	Nov 29 - Feb 4	Nov 29 - Feb 4	Dec 4 - Jan 23	Nov 6 - Jan 28	Nov 1 - Dec 31
Late Winter	Jan 24 - Apr 10	Feb 5 - May 4	Feb 5 - May 9	Jan 24 - Apr 10	Jan 29 - Apr 7	Jan 1 - Apr 14

*For north-eastern, spring is referred to as ‘calving’ in the data set.

Table 1.3. Number of sampling sites where field data were collected in the summers of 2021 and 2022 within each high- or moderate-density caribou use strata for each season used to assess differences among harvested and burned stands, and stands used by caribou, in Alberta, Canada.

Season	Caribou use
Spring	29
Calving	32
Summer	57
Fall	34
Early Winter	47
Late Winter	57

Table 1.4. Number of sampling sites where field data were collected in the summers of 2021 and 2022 within cutblock, wildfire, and caribou use sites within each natural subregion (NSR) used to assess differences among harvested and burned stands, and stands caribou use, in Alberta, Canada. The location of these sampling sites is shown in Figure 1.2.

NSR	Cutblock	Wildfire	Caribou use
Central Mixedwood	49	100	69
Lower Boreal Highlands	45	76	54
Upper Boreal Highlands	29	37	19
Lower Foothills	57	8	0
Upper Foothills	71	43	114

Table 1.5. Characteristics of natural subregions (NSR) sampled from cutblock, wildfire, and caribou use sites in Alberta, Canada in 2021 and 2022.

Natural subregion	**Area (km^2) [a]**	**Elevation (m) [b]**	**Vegetation (dominant tree species)**	**% Wetlands**	**MAP (mm) [c]**	**MAT (° C) [d]**	**Land use [e]**
Central Mixedwood	167,856	525 (200–1050)	Closed-canopy mixedwood forests (aspen, white spruce, jack pine, black spruce)	40	478	0.2	Forestry, oil and gas, agriculture
Lower Boreal Highlands	55,615	675 (400–1050)	Mixed forests (aspen, balsam poplar, black and white spruce, paper birch)	30	495	-1.0	Forestry, oil and gas
Upper Boreal Highlands	11,858	825 (650–1150)	Coniferous forests (lodgepole pine, jack pine, black spruce)	35	535	-1.5	Forestry, oil and gas
Lower Foothills	44,899	950 (650–1625)	Mixedwood forests (aspen, lodgepole pine, white spruce)	20	588	1.8	Forestry, oil and gas, agriculture
Upper Foothills	21,537	1300 (950–1750)	Closed coniferous forests (lodgepole pine, black spruce, white spruce)	10	632	1.3	Forestry, oil and gas

Notes: Adapted from Natural Regions Committee (2006). [a] Total area of natural subregion. [b] Averages are presented for elevation with range in (). [c] MAP = mean annual precipitation. [d] MAT = mean annual temperature. [e] Land use with a focus on anthropogenic disturbances

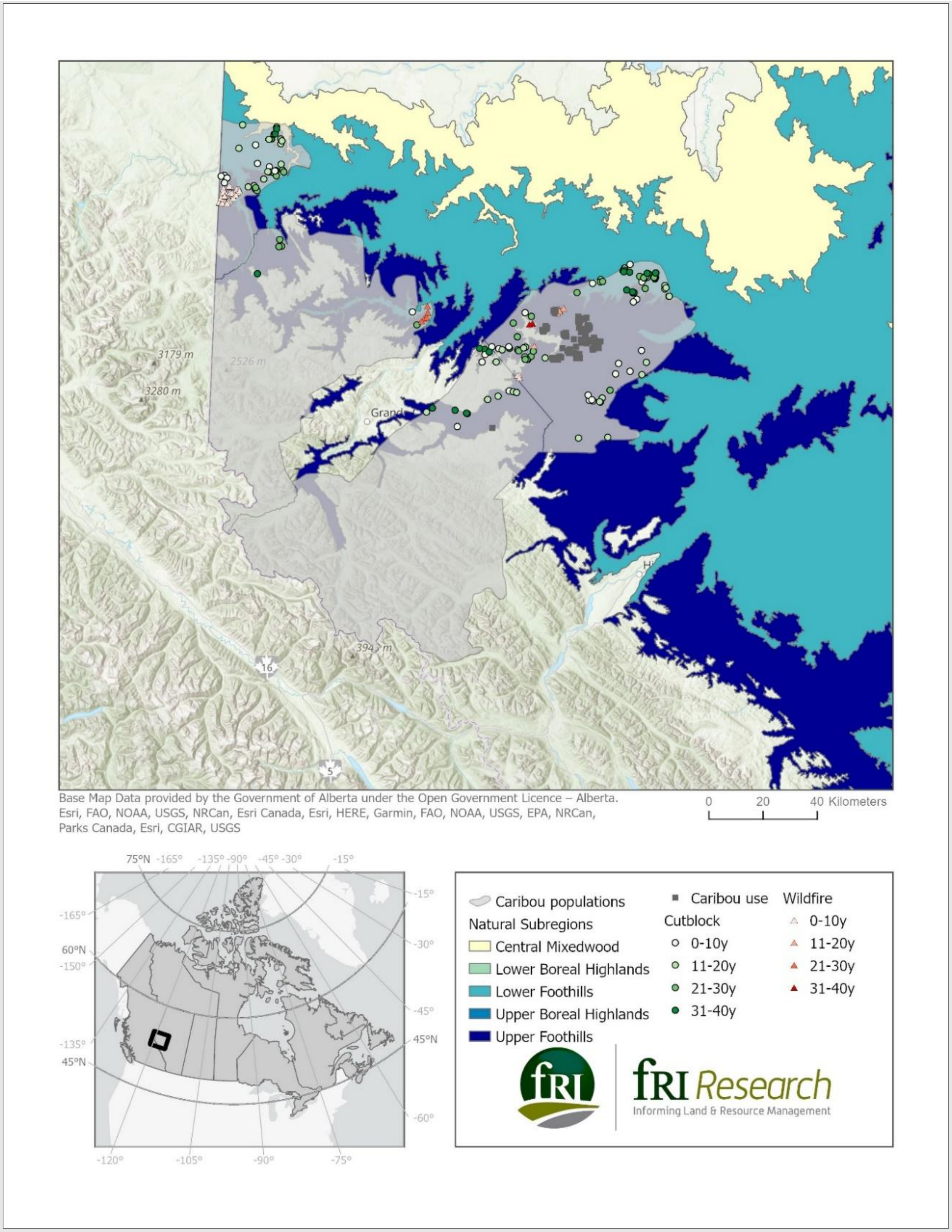

Figure 1.2. West-central region of study area in Alberta, Canada, showing the location of sampling sites where field data were collected between 2021 and 2022 to assess differences among harvested and burned stands, and stands caribou use.

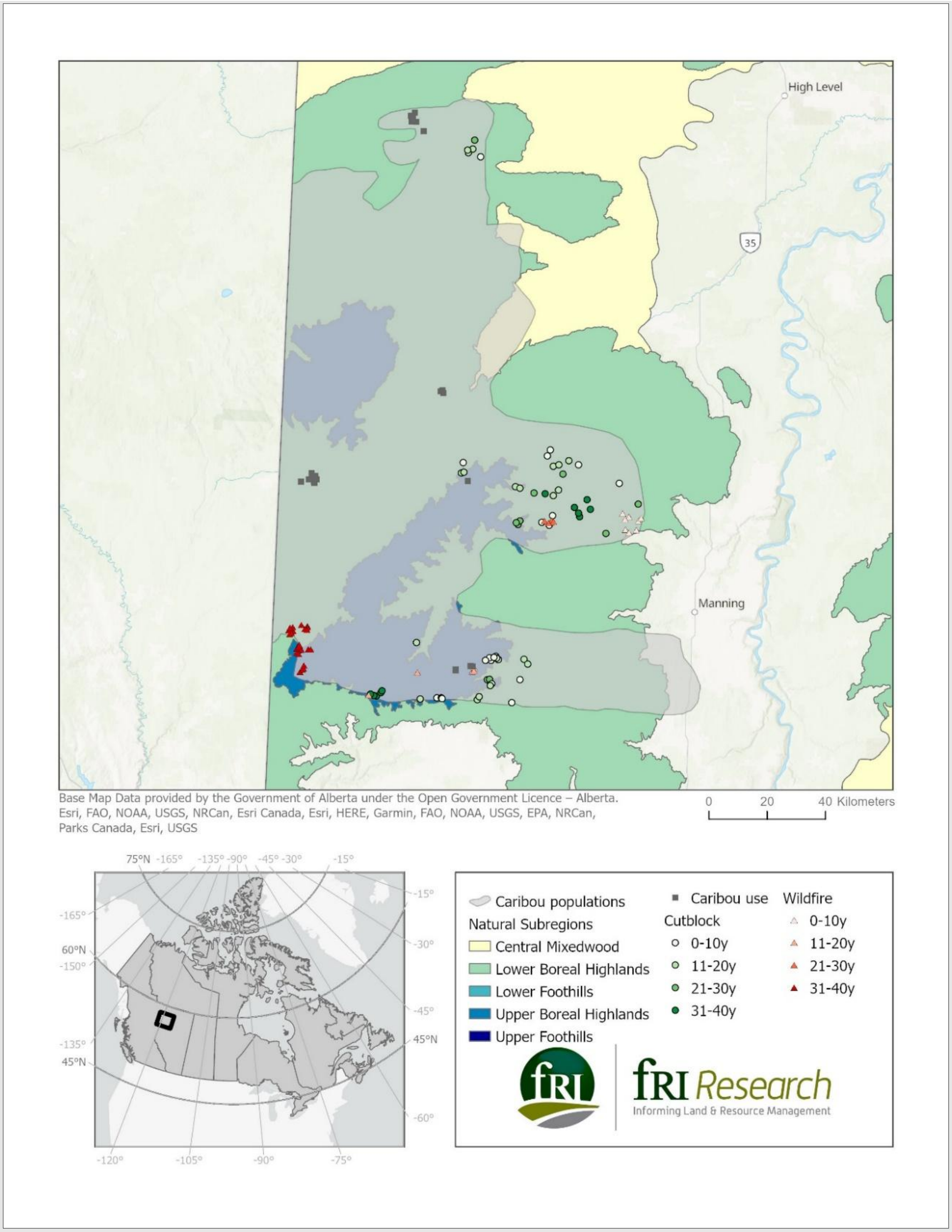

Figure 1.3. North-western region of study area in Alberta, Canada, showing the location of sampling sites where field data were collected between 2021 and 2022 to assess differences among harvested and burned stands, and stands caribou use.

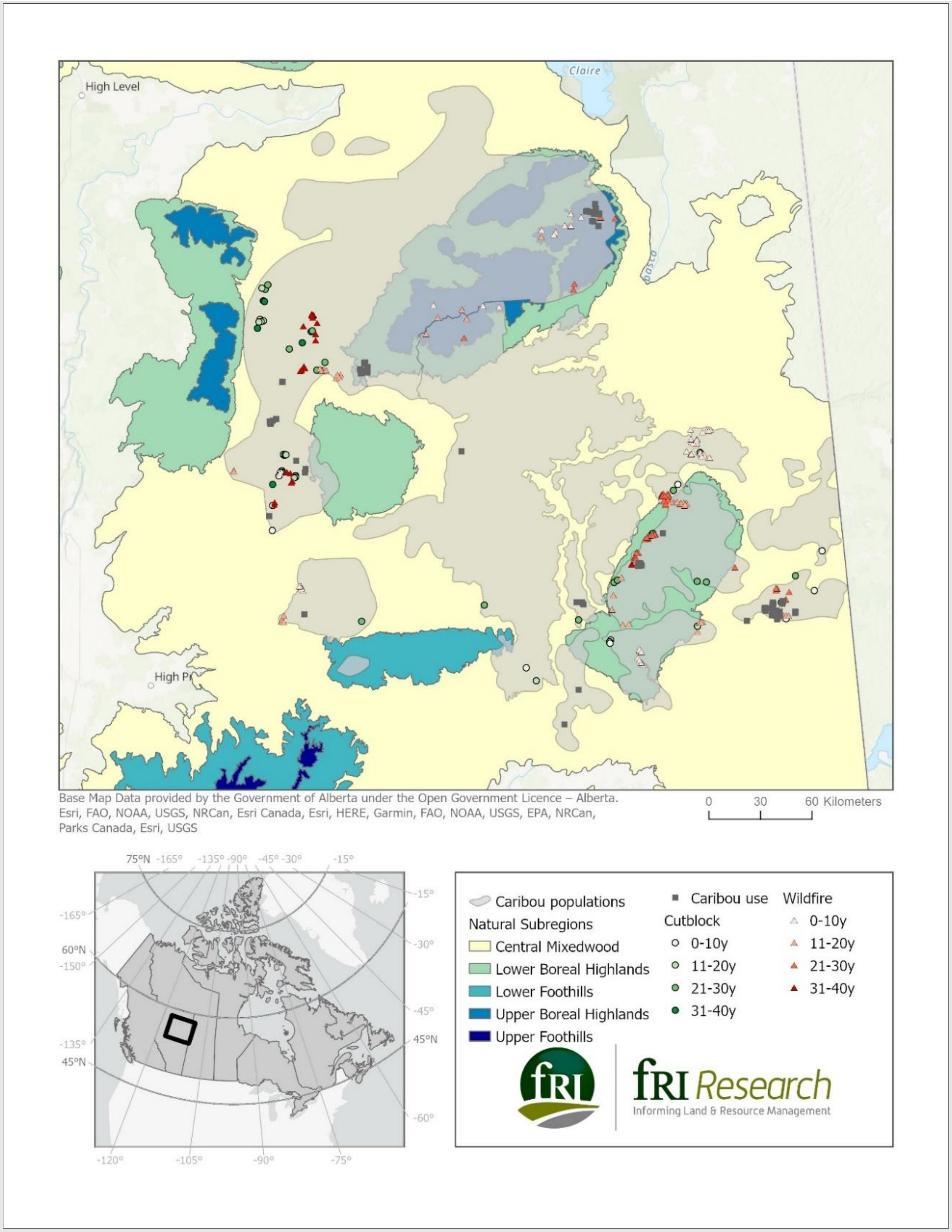

Figure 1.4. North-eastern region of study area in Alberta, Canada, showing the location of sampling sites where field data were collected between 2021 and 2022 to assess differences among harvested and burned stands, and stands caribou use.

1.3.2. Field data collection

Field crews established 100-m^2 circular plots (5.64 m radius) at each sampling site. Within each plot, crews recorded forest stand data including information on trees, coarse woody debris (CWD), understory vegetation, lateral cover, and soil (Table 1.6; Figure 1.3). Tree data were collected within the 100-m^2 sampling plot, and included diameter at breast height (DBH), species composition, age, height, and density counts (stems/ha) for all trees with a DBH ≥ 5cm, species composition and density counts for saplings (DBH <5cm), the status of each tree: alive, snag (dead tree ≥1.3m in length, leaning ≤45° from the vertical), or stump (dead tree <1.3m high), and the disease status of each tree (mountain pine beetle, blister rust).

CWD data were collected along four transects (5.64m in length) within the 100-m^2 plot, one in each cardinal direction, and included counts of CWD intersecting each transect. CWD consisted of logs on the ground and downed woody material at an angle of >45° from the vertical, >5cm diameter, >1m length, and >50% above forest litter or soil where measured. Due to time constraints, crews used a three-class decomposition classification for CWD: type I—little to no decay with intact bark and hard wood; type II—significant decay and bark is mostly gone, wood has begun to soften but retains structure; and type III—debris is soft throughout with a lack of structure. Crews counted the number of pieces of each CWD type along each transect, identifying species when possible, and recorded if the CWD was on the ground or suspended.

For understory vegetation, field crews measured percent cover of large shrubs within 5-m^2 circular plots (1.26 m radius) at the north, east, south, and west edges of the 100-m^2 plot. For target large shrubs (Table A2) with a basal stem diameter >0.5cm, crews also recorded height and stem counts by basal diameter class. Within 1-m^2 circular plots (0.564 m radius) within each of these 5-m^2 plots, field crews measured percent cover of dwarf shrubs, forbs, graminoids, terrestrial lichens, and other ground cover (Table A3). Crews used a cover board to measure lateral cover from the plot centre in each cardinal direction, with the cover board positioned 15m from the plot centre for each reading. Lateral cover was measured at two heights: 0–1m and 1–2m. For soil, field crews measured the depth to the organic soil layer at the centre of each of the four subplots, and recorded soil layers (litter, fermented, humus, peat). Canopy cover was also measured at the centre of each subplot using a spherical crown densiometer.

Table 1.6. Field data collected at sampling sites in the summers of 2021 and 2022 to assess differences among harvested and burned stands, and stands caribou use in Alberta, Canada.

Name	Description
Tree data	
Species	Tree/sapling species – see Table A1 for list
Count	Count of trees/saplings
DBH	Diameter at breast height, trees ≥ 5cm, saplings <5cm
Height	Estimate of height to the nearest 0.5m, by eye
Disease	Status of mountain pine beetle affected trees – none, green red, grey. Blister rust
Burned	Yes/No
Age	Whorl count, core/cookie for 3 largest trees in 100-m^2 plot
Status	Alive, snag (dead, ≥1.3 m in length, ≤45°from vertical), stump (<1.3 m high)
Lichen	Lichen class (0-5) for arboreal lichens
Canopy cover	% canopy cover measured using a densiometer, recorded at centre of each 5-m^2 subplot
CWD data	
Count	CWD count by status (I, II, or III) along each transect
Species	Species of each CWD along transect
Large shrubs	
Percent cover	Percent cover of all large shrubs within 5-m^2 subplot
Stem counts	Stem counts of target large shrubs (Table A2) by basal diameter class
Height	Height of target large shrubs (Table A2) by basal diameter class
Dwarf shrubs, forbs, gramminoids, terrestrial lichens, other ground cover	
Percent cover	Percent cover of all dwarf shrubs, forbs, gramminoids, terrestrial lichens, other ground cover within 1-m^2 subplot
Lateral cover	
0–1m	% lateral cover, with cover board touching the ground, from centre to each cardinal direction
1–2m	% lateral cover, with cover board 1m off ground, from centre to each cardinal direction
Soil	
Depth	Depth (cm) to organic soil layer

Figure 1.5. Data collection in the field showing soil sampling in a caribou used site (left) and measuring DBH in a wildfire site (right).

1.4. Objectives

This project had 4 objectives, Objective 1 was completed in February 2021, Objectives 2 through 4 are outlined in this report (Chapters 2 through 4 respectively)

1. Literature review [Complete] – see https://friresearch.ca/publications/caribou-fire-and-forestry
   - Summarize previous research investigating caribou response to fire and harvest disturbances, including research from ranges within Alberta and research from ranges in similar landscapes elsewhere in Canada.
   - Accepted for publication in peer reviewed literature (Stevenson et al. accepted)
2. Stand characteristics of areas with documented use by woodland caribou in Alberta [Chapter 2]
   - Specific information regarding forest stand characteristics within areas of caribou use
   - Summary statistics of stand characteristics compared between season and natural subregion
   - Statistical analysis of differences in stand characteristics and availability of wildlife forage among Natural Subregions
3. Comparing cutblock, wildfire, and caribou use sites [Chapter 3]
   - Information regarding differences in stand characteristics and vegetation understory between harvested areas, areas affected by wildfires, and areas used by caribou – statistical models specific to Natural Subregions
   - Published in peer reviewed literature (Best et al. 2024)
   - Investigate relationships between stand characteristics and forage availability among cutblock, wildfire, and caribou use sites – statistical models account for variation among Natural Subregion and are specific to disturbance type
   - Under review in peer reviewed literature
4. Assessment of historical cutblock and wildfire sites for their ability to produce future woodland caribou habitat [Chapter 4]
   - Assessment of future stand conditions following timber harvest or wildfire with the use of growth-and-yield forest models
   - Information on projections for stand characteristics (overstory and understory vegetation) and components of habitat for caribou compared between timber harvest and wildfire and among Natural Subregion

- Comparison of projected values of stand characteristics to those in sites with documented caribou use

5. Synthesis and conclusions
    - Key results from each chapter illustrating differences in stand characteristics and habitat for caribou among sites sampled
    - Limitations in data and analyses
    - General recommendations and application of findings

2. Stand characteristics of areas with documented use by woodland caribou in Alberta

2.1. Background

Caribou need large tracts of mature forest to maintain self-sustaining populations (Environment Canada 2011, Festa-Bianchet et al. 2011, Beauchesne et al. 2014, Johnson et al. 2020). However, the specific stand characteristics of the forests required by caribou are less well understood and are likely to vary at local scales as the tree composition of the boreal and montane forest changes across the widespread range of boreal and mountain caribou. Caribou response to forest stands is also likely to vary across seasons (DeCesare et al. 2012, Hornseth and Rempel 2016). Habitat selection analyses for caribou usually use broad categories of landcover data (conifer, mixed, deciduous, open, closed canopy) within models, which are too general to be useful for forest managers who use detailed forest stand data (tree species, age, stand densities, etc.) for forest management plans (Rudolph et al. 2019).

In Alberta, numerous studies have used satellite-derived or Alberta Vegetation Inventory (AVI)-derived data to assess caribou response to broad categories of forest stands. These studies found that in the north-east, boreal caribou selected bogs and fens with less canopy cover, and in some areas also selected uplands (Bradshaw et al. 1995, Stuart-Smith et al. 1997, Schneider et al. 2000, Tracz 2005). In the north-west, boreal caribou selected bogs and fens, and additionally conifer forests with less canopy cover (Brown et al. 2000, Pigeon et al. 2016). In west-central Alberta, boreal caribou selected conifer forests with dense canopy cover during summer and open canopy during winter (Neufeld 2006, DeCesare et al. 2012), while central mountain caribou generally selected open conifer and avoided deciduous and mixed forest (Szkorupa and Schmiegelow 2003, DeCesare et al. 2012, Slater 2013, Rudolph et al. 2019).

Fewer studies in Alberta have included information on stand characteristics like tree species, height, age, and understory composition and structure. Previous stand-level studies were focused within one area of the province, limiting their application to other populations of caribou. In north-west Alberta, a study using remote-sensing based measurements of stand characteristics found that caribou selected areas with less canopy cover, lower stand densities, and moderate stand heights (Wilson et al. 2023). In west-central Alberta, boreal caribou selected lodgepole pine, mixed pine and black spruce, and treed muskeg, and avoided white spruce (Neufeld 2006). Central mountain caribou from the Narraway herd selected older conifer stands and pine stands regardless of stand age or canopy cover, or black spruce forests and areas with greater abundance of *Cladina* spp. lichens (Saher 2005), and Redrock Prairie

Creek caribou selected stands 120-160 years old, with > 50% crown closure (Szkorupa and Schmiegelow 2003), as well as fire-origin conifer during late winter (Rudolph et al. 2019).

Understanding the stand characteristics of forests used by caribou is fundamental for landscape management and restoration. Specifically, this information may be used to design forest management plans, implement silvicultural practices that can lead to the restoration of caribou habitat, and determine when a disturbed area may be considered caribou habitat. In this Chapter, we used field data to describe the characteristics of forest stands used by caribou across Alberta, and to determine how those stand characteristics differed among Natural Subregions.

2.2. Methods

2.2.1. Stand characteristics

We selected stand characteristics that reflect timber supply, influence understory growing conditions, and support biodiversity (Table 2.1). The stand characteristics important for timber supply included basal area (all tree types, deciduous, coniferous; $m^2\ ha^{-1}$), quadratic mean diameter (QMD, in cm), and stems per hectare (SPH). These timber supply metrics were calculated based only on living trees (DBH ≥ 5cm), excluding snags and stumps. We also focused on stand characteristics that could influence the abundance of understory vegetation, such as basal area (including snags and stumps), canopy cover, coniferous saplings, coarse woody debris (CWD), and soil depth (in cm) (Table 2.1). Because total number of saplings and number of coniferous saplings were highly correlated (Pearson $r = 0.936$, $p < 0.001$), we focused on the latter to better describe potential future timber supply. We defined a downed CWD variable following the protocol of Harmon and Sexton (1996), which included counts of downed debris of all decomposition classes (described in section 1.3.2, Table 1.6), as well as a CWD variable that included counts of downed CWD and standing dead trees: snags and stumps (described in section 1.3.2, Table 1.6).

2.2.2. Development of forage groups

Forest stand characteristics can influence the availability of understory forage preferred by wildlife (e.g., Coxson and March 2001; Waterhouse et al. 2011; Nadeau Fortin et al. 2016). Since forage is a primary predictor of wildlife use of areas (e.g., Massé and Côté 2009; Nielsen et al. 2010; van Beest et al. 2010), we assessed availability of wildlife forage in addition to stand characteristics within stands. In western Canada, the preferred winter forage of caribou is terrestrial and arboreal lichens (Johnson et al. 2001; Bergerud et al. 2008; Denryter et al. 2017). The availability of lichens typically decreases following clearcut harvesting and wildfire (Coxson and Marsh 2001; Russell and Johnson 2019) and can take up to 40–50 years to recover post-disturbance (Nguyen-Xuan et al. 2000; Joly et al. 2003). Conversely, generalist ungulates, like moose, favor vascular plants, which are abundant in early seral forest (Franzmann and Schwartz 1997; Visscher et al. 2006; DeCesare et al. 2010). Predators including black bears and grizzly bears also prefer early seral forests to access forbs and berry-producing shrubs (Latham et al. 2011; Souliere et al. 2020). An assessment of forage availability for caribou, moose, and bears can be an effective indicator of habitat, especially for caribou, as increased forage for moose and bears could reflect greater use of areas by moose and bears (Johnson et al. 2020; McKay and Finnegan 2022), and greater predation risk for caribou (DeCesare et al. 2010; Serrouya et al. 2021; Peters et al. 2013).

We defined groups of plants and lichens representative of forage preferred by caribou, moose, and bears (Table 2.1). Terrestrial lichens comprise a large portion of winter diets of caribou, but during spring and summer deciduous forbs are often consumed (Thomas et al. 1996, Barten et al. 2001, Denryter et al. 2017). During winter, moose often browse on sapling foliage, and shift to herbaceous plants and shrubs during other seasons (Franzmann and Schwartz 1997; Visscher et al. 2006; Koetke et al. 2023). Although animal tissue and invertebrates are major components of the diets of black bears and grizzly bears, fruiting shrubs, forbs, and roots are important during spring and summer (Nielsen et al., 2004; Munro et al., 2006; Merkle et al., 2017).

We summed the percent cover of lichen, shrub, and forb taxa within each group, then calculated mean percent cover for each group across the four subplots within each 100-m^2 plot. For the forage group including saplings, we calculated the total stem count of the target species for each site. We rounded values to the nearest whole number and if any sites (100-m^2 plots) had mean values between 0–0.5 we rounded up to 1 to not exclude any plots with forage occurrence.

Table 2.1. Stand characteristics included in analysis for Chapter 2, 3, and 4. Derived from field data collected at sampling sites in the summers of 2021 and 2022 (Table 1.5)

Stand characteristic/ Forage group	Definition	Range
Timber supply metrics [a]		
Basal area (BA.Alive)	Total basal area of alive trees (DBH ≥ 5 cm) per site (m^2 ha^{-1})	0–79.79
Deciduous basal area (BA.d.Alive)	Basal area of alive deciduous trees (DBH ≥ 5 cm) per site (m^2 ha^{-1})	0–79.79
Coniferous basal area (BA.c.Alive)	Basal area of alive coniferous trees (DBH ≥ 5 cm) per site (m^2 ha^{-1})	0–67.56
Quadratic mean diameter (QMD)	Quadratic mean diameter of alive trees in a site (cm)	0–39.01
Stems per hectare (SPH) [b]	Total stems per hectare of alive trees per site (trees/ ha)	0–9500
Influence understory (forage models) [c]		
Basal area (BA)	Total basal area of trees per site (m^2 ha^{-1}); all tree types (coniferous, deciduous), all status of trees (alive, snag, stump)	0.0–124.4
Deciduous basal area (BA.d)	Basal area of deciduous trees per site (m^2 ha^{-1}); all status of trees (alive, snag, stump)	0.0–124.4
Canopy cover (CC)	Percent canopy cover measured in site	0–96
Coniferous saplings (CS)	Total count of coniferous saplings (DBH < 5 cm) per site	0–1988
Coarse woody debris (CWD) [d]	Total counts of downed debris (all classes; suspended or on ground) and dead standing trees (snags, stumps) per site	0–85
Downed CWD (dCWD)	Total counts of downed debris (all classes; suspended or on ground) per site	0–50
Soil depth (SD)	Depth to organic soil layer (cm) in site	0.1–117.0
Forage group		
Caribou forbs	Percent cover of target forbs, dwarf shrubs, graminoids (*Elymus innovates, Lathyrus ochroleucus, Trifolium* spp., *Vaccinium* spp.)	0–48
Caribou lichens	Percent cover of target terrestrial lichens (*Cetraria* spp., *Cladina* spp., *Cladonia* spp., *Flavocetraria* spp.)	0–82
Moose forbs	Percent cover of target forbs, dwarf shrubs, graminoids (*Aralia nudicaulis, Carex* spp.*, Chamerion* spp.*, Cornus canadensis, Rhododendron groenlandicum, Rubus idaeus*)	0–70
Moose saplings	Total count of target saplings (*Abies balsamea, Abies lasiocarpa, Betula papyrifera, Populus balsamifera, Populus tremuloides*)	0–483
Moose shrubs	Percent cover of target large shrubs (*Amelanchier alnifolia, Cornus stolonifera, Prunus virginiana, Salix* spp., *Viburnum edule*)	0–69
Bear forbs	Percent cover of target forbs, dwarf shrubs (*Aralia nudicaulis, Equisetum* spp., *Rubus idaeus, Trifolium* spp., *Vaccinium* spp., *Vaccinium vitis-idaea*)	0–58
Bear shrubs	Percent cover of target large shrubs (*Lonicera involucrate, Ribes* spp., *Shepherdia canadensis, Viburnum edule*)	0–50

Notes: Site refers to 100-m^2 plot. [a] only included living trees (DBH ≥ 5 cm) in measurements (excluded snags and stumps). [b] extrapolated to the hectare scale. [c] stand characteristics included in forage models (section 3.2.2). [d] variable of focus in analysis in Chapter 2, and section 3.2.1; not included in forage models (section 3.2.2).

2.2.3. Data analysis

We tested for differences in stand characteristics and forage groups among NSRs in caribou use sites. Since no caribou use sites were sampled in the Lower Foothills, the Lower Foothills was excluded from subsequent analyses (Chapter 2). Despite stratifying data collection by ecosite, there was insufficient variation in the field data collected to include ecosite in the analysis. For caribou use sites, we compared the stand characteristics between seasons (spring, calving, summer, fall, early winter, late winter) for each NSR, but due to the limited sample size of some groups (Table 2.2) we were not able to statistically test for differences. For means and standard errors of the stand characteristics for each season within the Central Mixedwood, Upper Foothills, and Lower and Upper Boreal Highlands, please refer to Figures A1–A3 in the Appendix.

The two basal area variables (BA.Alive vs. BA) and two deciduous basal area variables (BA.d.Alive vs. BA.d) were highly correlated (BA: Pearson $r = 0.828$, $p < 0.001$; BA.d: Pearson $r = 0.830$, $p < 0.001$), so for the following analysis (Chapter 2) we focused on the measures that only included alive trees.

We used generalized linear models to examine the relationship between stand characteristics and NSR for all the caribou use sites pooled together. We used gaussian linear regression (link = identity) for timber supply metrics, canopy cover, coniferous saplings, and soil depth. For CWD and the forage groups, we used negative binomial count models (link = log) due to the overdispersed distribution of the data (“MASS” package; Venables and Ripley 2002). In all models, NSR was included as a fixed effect and we used deviation coding to obtain coefficient estimates for each category. We performed post hoc analyses based on estimated marginal means with pairwise comparisons and “Tukey” p-value adjustments to test for differences between NSR groups (“emmeans” package; Lenth 2023). Normality of the response variables was confirmed based on the residuals of the models. We considered significance at $\alpha = 0.05$. All statistical analyses were performed using the software R v. 4.1.3 (R Development Core Team 2022).

Table 2.2. Number of sampling sites where field data were collected in the summers of 2021 and 2022 within each natural subregion for high- or moderate-density caribou use strata for each season.

Natural subregion	Spring	Calving	Summer	Fall	Early winter	Late winter
Central Mixedwood	0	18	18	0	15	18
Lower Boreal Highlands	4	11	15	10	9	5
Upper Boreal Highlands	1	3	2	2	3	8
Lower Foothills	0	0	0	0	0	0
Upper Foothills	24	0	22	22	20	26

2.3. Results

Basal area (BA.Alive) of forest stands in caribou use sites was 0–67.56 m^2ha^{-1}, QMD was 0–26.84 cm, and SPH was 0–7000. Despite a lack of significant differences, basal area, QMD, and SPH were marginally smaller in the Central Mixedwood compared to the other NSRs for caribou use sites (Table 2.4, Figure 2.1). These three timber supply metrics were slightly greater in the Upper Foothills and Upper Boreal Highlands (Table 2.4, Figure 2.1). Basal area of deciduous and coniferous trees were 0–53.14 and 0–67.56 m^2ha^{-1}, respectively. In the Central Mixedwood, deciduous basal area was greatest and coniferous basal area was the least (Table 2.4, Figure 2.1).

Canopy cover in caribou use sites was 0–94%. Canopy cover was marginally greater in the Upper Boreal Highlands and counts of CWD were greater in the Upper Foothills (Table 2.4, Figure 2.2). Counts of coniferous saplings and CWD in caribou use sites were 0–243 and 0–36, respectively. We did not detect any significant differences between NSR for counts of coniferous saplings (Table 2.4, Figure 2.2). Soil depth in caribou use sites was 0.63–117 cm and was greatest in the Central Mixedwood and lowest in the Upper Boreal Highlands (Table 2.4, Figure 2.2).

Percent cover of caribou forbs and caribou lichens in caribou use sites were 0–43% and 0–82%, respectively. In caribou use sites, caribou forbs were least abundant in the Central Mixedwood (Table 2.4, Figure 2.3). Caribou lichens were more abundant in the lower and Upper Boreal Highlands, compared to the other two NSRs (Table 2.4, Figure 2.3). Percent cover of moose forbs and shrubs in caribou use sites were 0–45 and 0–41%, respectively. Moose forbs and moose shrubs were less abundant in the Foothills compared to the Central Mixedwood and Lower Boreal Highlands (Table 2.4, Figure 2.4). Counts of moose saplings in caribou use sites were 0–55. We did not observe notable differences among NSRs for moose saplings (Table 2.4, Figure 2.4). Percent cover of bear forbs and bear shrubs in caribou use sites were 0–44 and 0–14%, respectively. Bear forbs were most abundant in the Upper Boreal Highlands and least abundant in the Central Mixedwood (Table 2.4, Figure 2.5). Bear shrubs were less abundant in the Upper Foothills compared to the boreal highlands (Figure 2.5).

Complete model results are in the Appendix (Tables A4, A5).

Table 2.3. Mean, standard error, and range (min. – max.) of stand characteristics measured in caribou use sites (all NSR data pooled together, n = 256).

Stand characteristic	Mean	Std. Error	Range
Basal area (BA.Alive; m^2 ha^{-1})	18.70	0.97	0 – 67.56
Deciduous basal area (BA.d.Alive; m^2 ha^{-1})	2.48	0.39	0 – 53.14
Coniferous basal area (BA.c.Alive; m^2 ha^{-1})	16.22	0.96	0 – 67.56
Deciduous trees (%)	17.80	2.05	0 – 100
QMD (cm)	10.82	0.28	0 – 26.84
SPH	1844.53	91.26	0 – 7000
Canopy cover (%)	40.20	1.72	0 – 94
Coniferous saplings (count)	50.52	3.19	0 – 243
CWD (count)	6.68	0.43	0 – 36
Soil depth (cm)	46.80	2.45	0.63 – 117
Caribou forbs (%)	4.43	0.41	0 – 43
Caribou lichens (%)	8.81	1.06	0 – 82
Moose forbs (%)	10.81	0.55	0 – 45
Moose saplings (count)	1.22	0.35	0 – 55
Moose shrubs (%)	1.40	0.24	0 – 41
Bear forbs (%)	9.34	0.55	0 – 44
Bear shrubs (%)	0.27	0.09	0 – 14

Table 2.4. Mean and range of values for each NSR in caribou use sites for variables describing stand characteristics and forage groups from field data collected at sampling sites in the summers of 2021 and 2022 (Table 1.5). Ranges are displayed in brackets. Full variable descriptions are in Table 2.1.

Stand characteristic/ Forage group	Central Mixedwood	Upper Foothills	Lower Boreal Highlands	Upper Boreal Highlands
Timber supply metrics [a]				
Basal area (BA.Alive)	11.02 (0–53.14)	23.16 (0–67.56)	17.61 (0–61.94)	22.92 (5.83–47.78)
Deciduous basal area (BA.d.Alive)	5.63 (0–53.14)	0.47 (0–10.94)	3.33 (0–36.00)	0.70 (0–9.65)
Coniferous basal area (BA.c.Alive)	5.39 (0–26.47)	22.69 (0–67.56)	14.28 (0–54.60)	22.22 (5.83–47.78)
Quadratic mean diameter (QMD)	8.86 (0–22.92)	12.30 (0–25.03)	10.13 (0–26.84)	11.07 (6.39–19.55)
Stems per hectare (SPH) [b]	1637.68 (0–5700)	1887.72 (0–5800)	1731.48 (0–7000)	2657.89 (500–5200)
Influence understory (forage models) [b]				
Basal area (BA)	12.99 (0–62.90)	28.93 (0–75.57)	20.64 (0–73.65)	24.57 (6.7–48.91)
Deciduous basal area (BA.d)	6.28 (0–62.90)	0.51 (0–10.94)	4.38 (0–41.51)	0.93 (0–11.00)
Canopy cover (CC)	32.40 (0–93.50)	43.65 (0–93.00)	38.12 (0–94.00)	54.46 (14.75–90.25)
Coniferous saplings (CS)	42.35 (0–175)	45.82 (0–198)	65.26 (0–234)	66.47 (15–243)
Coarse woody debris (CWD) [c]	3.97 (0–24)	8.80 (0–31)	5.81 (0–36)	6.21 (0–30)
Downed CWD (dCWD)	1.33 (0–14)	2.77 (0–14)	2.06 (0–11)	3.10 (0–20)
Soil depth (SD)	77.03 (0.88–102.00)	34.69 (1.00–110.00)	45.45 (0.63–117.00)	13.46 (2.75–29.50)
Forage group				
Caribou forbs	1.84 (0–13)	5.70 (0–43)	3.85 (0–36)	7.84 (0–31)
Caribou lichens	4.64 (0–60)	3.70 (0–50)	17.02 (0–82)	31.26 (0–76)
Moose forbs	11.72 (0–31)	8.39 (0–35)	15.69 (0–45)	8.21 (3–20)
Moose saplings	1.39 (0–55)	0.49 (0–15)	2.48 (0–38)	1.32 (0–12)
Moose shrubs	2.43 (0–21)	0.48 (0–8)	2.17 (0–41)	0.95 (0–6)
Bear forbs	6.54 (0–38)	8.95 (0–44)	11.18 (0–40)	16.58 (0–40)
Bear shrubs	0.16 (0–7)	0.09 (0–2)	0.91 (0–14)	0.00 (0–0)

Notes: [a] only included living trees (DBH ≥ 5 cm) in measurements (excluded snags and stumps). [b] stand characteristics included in forage models (section 3.2.2). [c] variable of focus in analysis in Chapter 2, and section 3.2.1; not included in forage models (section 3.2.2).

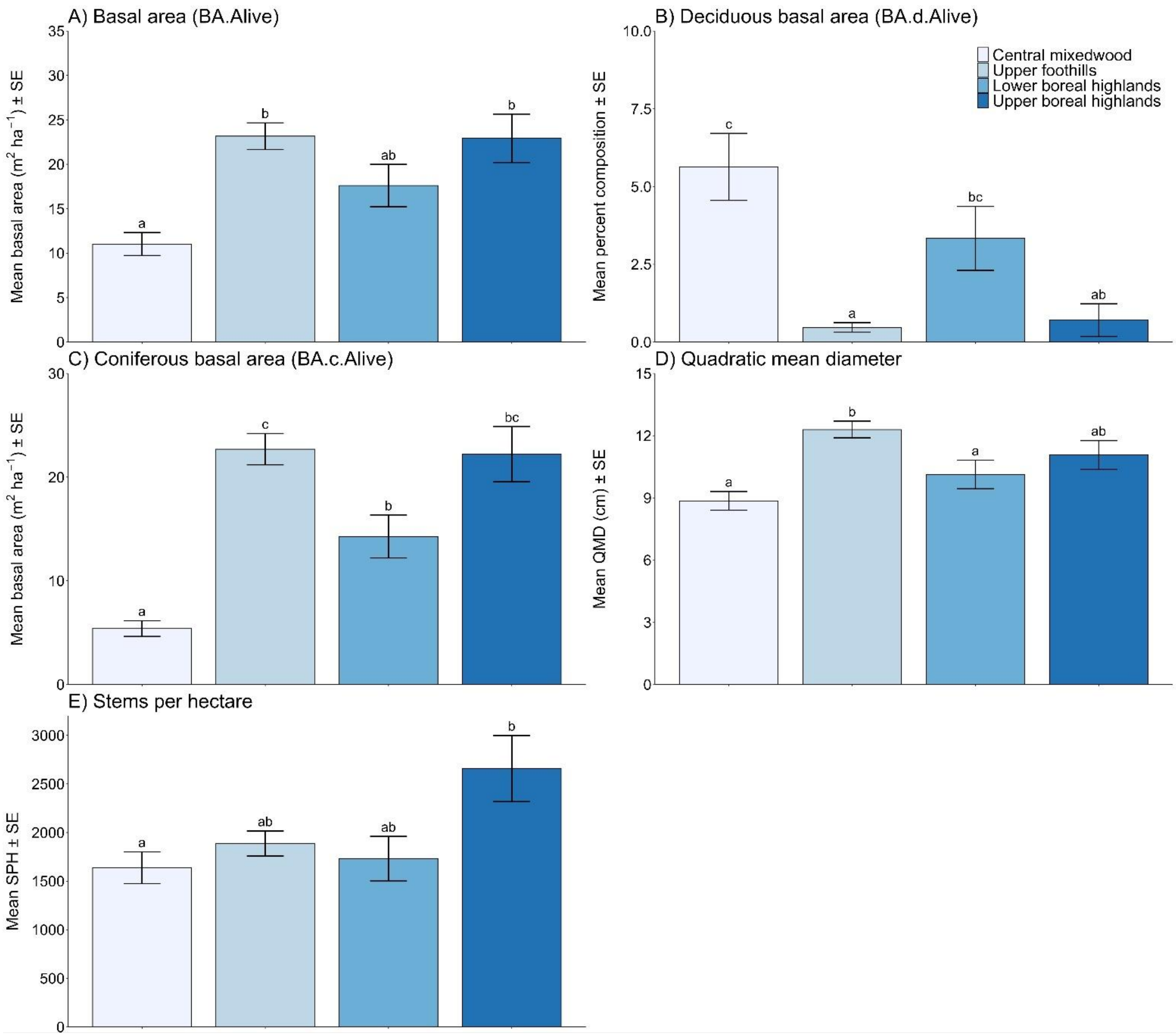

Figure 2.1. Mean values of timber supply metrics A) Basal area (BA.Alive), B) Deciduous basal area (BA.d.Alive, C) Coniferous basal area (BA.c.Alive), D) Quadratic mean diameter (QMD), and E) Stems per hectare (SPH) compared between natural subregions (Central Mixedwood, Upper Foothills, Lower Boreal Highlands, Upper Boreal Highlands). Error bars represent standard error (SE) of the mean. Both mean and SE were calculated from the raw data. Differences in letters (a,b,c) indicate significant differences based on pairwise comparisons of estimated marginal means from GLMs (Table A4).

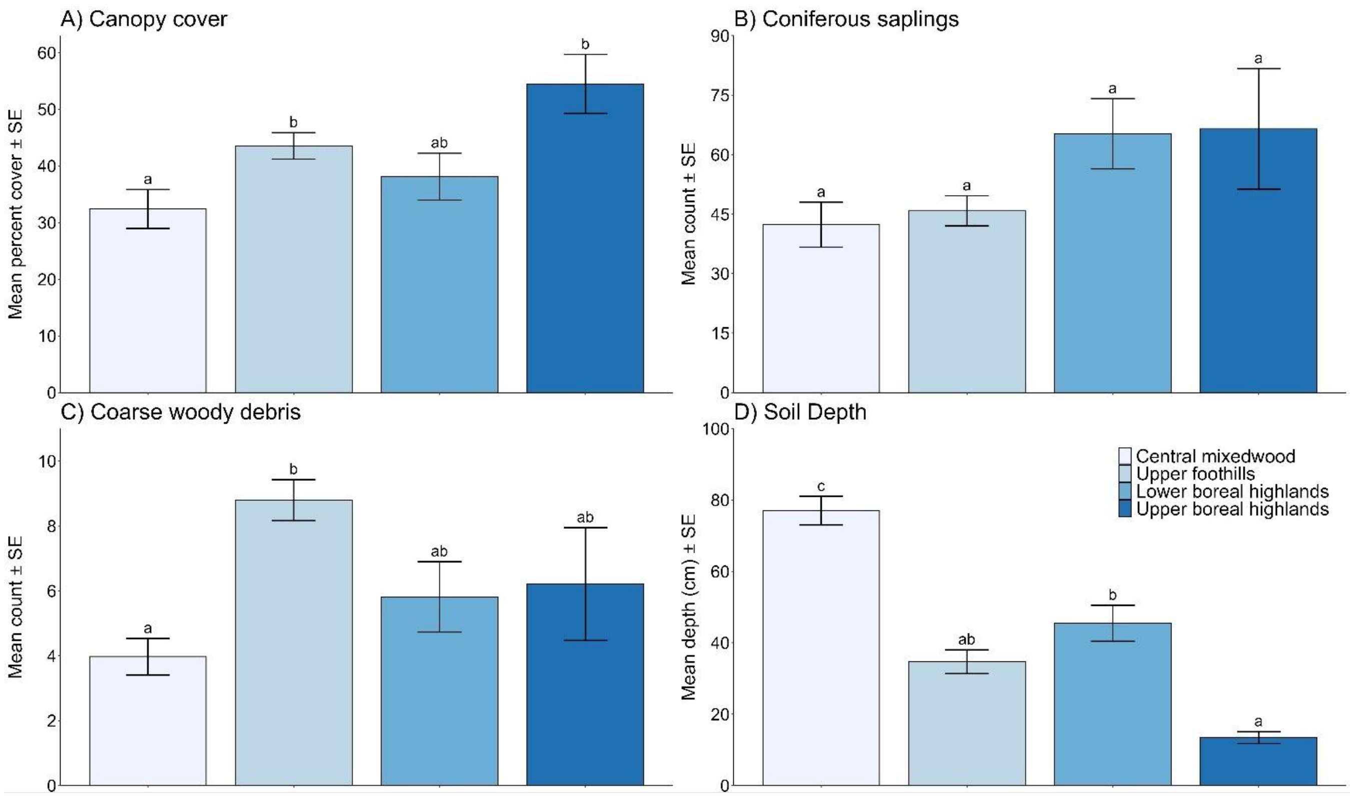

Figure 2.2. Mean values of stand characteristics A) Canopy cover, B) Coniferous saplings (count), C) Coarse woody debris (CWD), and D) Soil depth compared between natural subregions (Central Mixedwood, Upper Foothills, Lower Boreal Highlands, Upper Boreal Highlands). Error bars represent standard error (SE) of the mean. Both mean and SE were calculated from the raw data. Differences in letters (a,b,c) indicate significant differences based on pairwise comparisons of estimated marginal means from GLMs (Tables A4, A5).

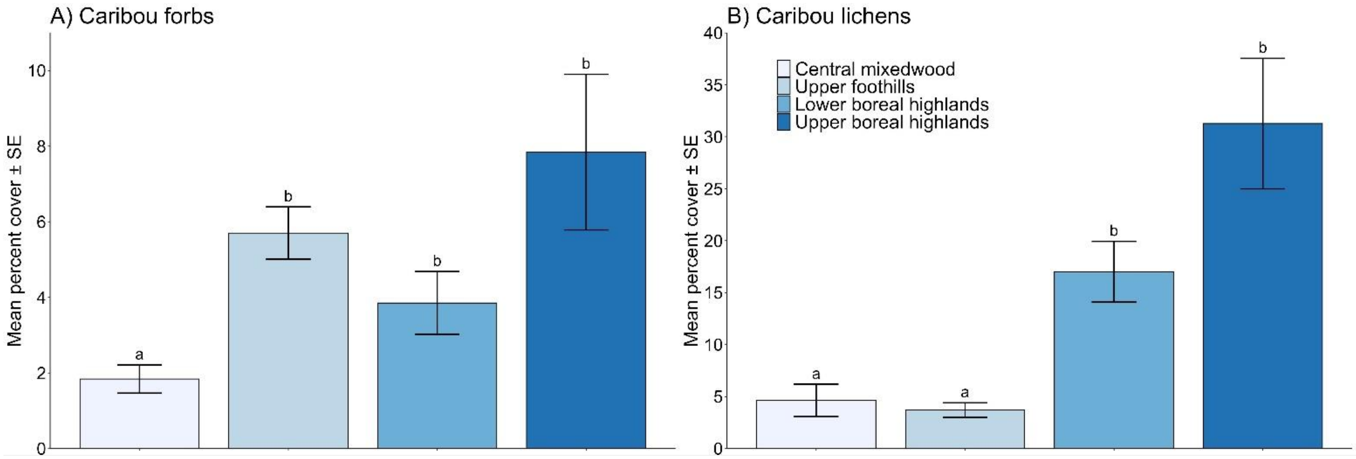

Figure 2.3. Mean values of forage groups A) Caribou forbs, and B) Caribou lichens compared between natural subregions (Central Mixedwood, Upper Foothills, Lower Boreal Highlands, Upper Boreal Highlands). Error bars represent standard error (SE) of the mean. Both mean and SE were calculated from the raw data. Differences in letters (a,b) indicate significant differences based on pairwise comparisons of estimated marginal means from GLMs (Table A5).

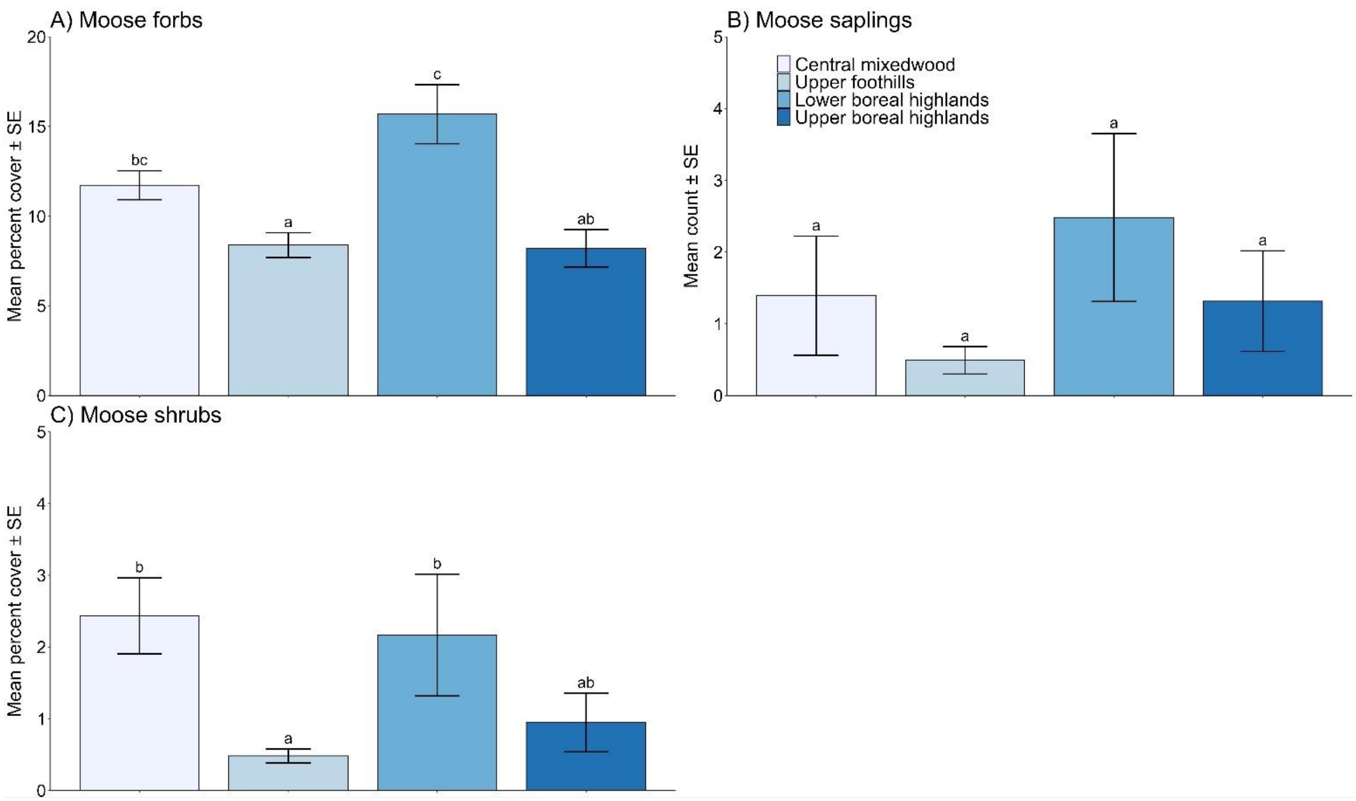

Figure 2.4. Mean values of forage groups A) Moose forbs, B) Moose saplings, and C) Moose shrubs compared between natural subregions (Central Mixedwood, Upper Foothills, Lower Boreal Highlands, Upper Boreal Highlands). Error bars represent standard error (SE) of the mean. Both mean and SE were calculated from the raw data. Differences in letters (a,b,c) indicate significant differences based on pairwise comparisons of estimated marginal means from GLMs (Table A5).

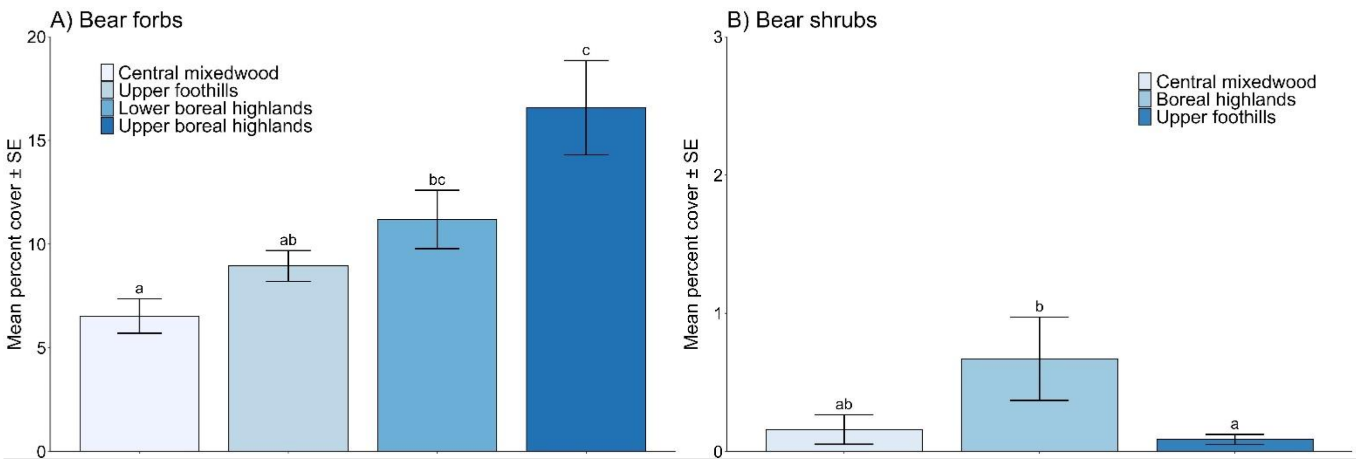

Figure 2.5. Mean values of forage groups A) Bear forbs, and B) Bear shrubs compared between natural subregions (Central Mixedwood, Upper Foothills, Lower Boreal Highlands, Upper Boreal Highlands). Error bars represent standard error (SE) of the mean. Both mean and SE were calculated from the raw data. Differences in letters (a,b,c) indicate significant differences based on pairwise comparisons of estimated marginal means from GLMs (Table A5). Bear shrubs were not observed in caribou use sites in the Upper Boreal Highlands, so values reflect sites in Lower Boreal Highlands.

2.4. Discussion

We did not detect many differences in stand characteristics among natural subregions for caribou use sites. The lack of significant differences between NSR for many of the stand characteristics could be attributed to the temporal range of the age of the caribou use sites that were sampled, which exceeded 100 years (range = 41-220 years). Stand characteristics like basal area, canopy cover, and SPH can be influenced by time since disturbance (Greene et al. 1999, Bartels et al. 2016). Since caribou use sites in all NSRs included a range of stand ages, differences could have been masked by stand age. Therefore, to better explain the variation of the data, in subsequent analyses (see Chapter 3) we factored in time since disturbance within models.

We found basal area of deciduous trees and soil depth was generally greater in the Central Mixedwood NSR, which could be explained by the environmental variation characterized by the respective NSRs (Natural Regions Committee 2006). As its name suggests, the Central Mixedwood is dominated by mixedwood forest, including species like aspen and birch, so it could be expected that even in mature forest found in the caribou use sites the tree composition would include a high percentage of deciduous trees (Natural Regions Committee 2006). Concerning edaphic conditions, such as the physical, chemical, or biological properties of soil (Estrada-Villegas et al. 2020), the Central Mixedwood caribou use sites also had the greatest number of hydric sites (Table A4), and generally had more wetlands compared to the other NSRs in our study area (Natural Regions Committee 2006). Deeper soils typically hold more water and nutrients (Rajakaruna and Boyd 2008), thus reflecting hydric, nutrient-rich edaphic conditions. These findings could also help explain the low abundance of caribou lichens in the Central Mixedwood. Terrestrial lichen growth can be restricted by moist, nutrient-rich soil conditions, which, in turn, can promote the growth of competitor taxa like mosses and woody shrubs (Coxson and Marsh 2001, Nobert et al. 2020, Cichowski et al. 2022). Furthermore, the forbs taxa inclusive in the caribou forbs and bear forbs forage groups may also be affected by the edaphic conditions, demonstrated by the lower abundance in the Central Mixedwood (Figures 2.3, 2.5).

The abundance of moose saplings, moose shrubs, and bear shrubs was low across NSRs in caribou use sites. These results are not surprising considering successional patterns of deciduous saplings and shade-intolerant shrub taxa included in the forage groups (Chen and Popadiouk 2002; Hart and Chen 2006; Bartels et al. 2016).

Overall, the caribou use sites were characterized by i) intermediate-levels of basal area, QMD, SPH, canopy cover, coniferous saplings, soil depth, and moose and bear forbs; ii) relatively fewer deciduous trees, counts of CWD, counts of moose saplings, and percent cover of caribou forbs, moose shrubs, and bear shrubs; and iii) greater abundance of caribou lichens (Table 2.3).

3. Comparing cutblock, wildfire, and caribou use sites

3.1. Background

Wildfire is the dominant stand-replacing disturbance across the boreal forest (Macias and Johnson 2008), although forest harvesting also alters approximately 650,000 ha annually (Komers and Stanojevic 2013, Curtis et al. 2018). Both wildfire and forest harvesting are polygonal disturbances that create early-seral forest conditions, but the response of vegetation and wildlife differs between the two disturbances (Stewart et al. 2020, Finnegan et al. 2021). Caribou generally avoid early-seral forests created by wildfires and forest harvesting (Dalerum et al. 2007, Courtois et al. 2008, Konkolics et al. 2021), but forest harvesting is thought to have a larger negative affect on the movements, demography, and habitat of caribou (for a full review see Finnegan et al. (2021)). Sustainable forest practices (harvesting patterns, silviculture) that aim to emulate natural disturbances like wildfire have the potential to reduce the impact of forest harvesting on wildlife, including species of conservation concern like caribou (Delong and Tanner 1996, Gauthier et al. 1996, Dhital et al. 2013, Nadeau Fortin et al. 2016, Donovan et al. 2017)

There has been considerable research describing differences between burned and harvested stands with respect to stand characteristics and understory vegetation (see Finnegan et al. (2021)). These studies were carried out in small geographic areas, preventing broad-scale comparisons of stand trajectories across natural subregions and time since disturbance. In this Chapter, we used field data collected across Alberta to compare the stand characteristics of harvested and burned stands with stands used by caribou, and to determine how these differ across natural subregions and time since disturbance.

We also tested for relationships between stand characteristics and availability of forage among the different site types. Caribou habitat use is influenced by landscape-scale characteristics like disturbance densities and exposure to predation risk, as well as fine-scale characteristics which vary as caribou trade off access to food against shelter from predators (Johnson et al. 2001; Avgar et al. 2015; Leblond et al. 2016), and which can vary with reproductive status (Viejou et al. 2018). Therefore, we assessed not only stand characteristics of caribou use sites, but also how those stand characteristics were linked to the availability of caribou forage. This information is important for understanding the characteristics of stands that are caribou habitat, as well as the stand conditions that represent caribou habitat that has recovered following human or natural disturbance. Finally, this information is necessary for understanding how stand characteristics influence the availability of moose and bear foods, sympatric species that indirectly or directly influence predation risk for caribou (Leblond et al. 2016; Serrouya et al. 2021).

3.2. Methods

We developed data analysis methods in collaboration with ARCKP members during March and April 2023. Because ARCKP members were interested in the impacts of silviculture treatments on forest stands, we evaluated whether there was enough variation in the field data to include age, NSR, ecosite, and simple descriptions of silviculture (whether herbicide was applied) within analysis. Despite stratifying data collection by ecosite, there was insufficient variation in the field data to include ecosite within analysis. There was also insufficient variation in field data to include silviculture treatments. After discussion with ARCKP members, we proceeded with analysis focused on age and NSR strata. In future studies, the removal of age or NSR strata may allow for an evaluation of the effect of silviculture treatments like planting densities, site preparation equipment, or site tending on the stand and forage data we collected. For example, by combining NSR and age strata of 117 harvest blocks sampled across the Lower and Upper Foothills, McKay and Finnegan (2023) were able to evaluate the influence of silviculture treatments on wildlife use of harvest blocks.

3.2.1. Comparison of stand characteristics among sites

3.2.1.1. Data analysis

We assessed the relationship between disturbance type and stand characteristics. We focused on timber supply metrics, stand characteristics that could influence understory (e.g., CWD, coniferous saplings), and forage groups (described in section 2.2.1, Table 2.1). We used GLMs to test for the effects of disturbance type and time since disturbance on the stand characteristics and forage groups. We built separate models for each NSR, except for the Lower and Upper Foothills where we pooled data due to insufficient sample sizes for some strata (i.e., 0 wildfire sites for age classes 11–20, 21–30, and 31–40 in the Lower Foothills). Like the models described in section 2.2.2, we used Gaussian linear regression (link = identity) for the timber supply variables and stand characteristics, and negative binomial count models (link = log) for CWD and forage groups. We developed a categorical variable ‘disturbance class’ to include all subgroups of ‘disturbance type’ and ‘time since disturbance' (0–10, 11–20, 21–30, 31–40, >40 years) within models. The ‘disturbance class’ factor included the levels: cutblock 0–10, wildfire 0–10, cutblock 11–20, wildfire 11–20, cutblock 21–30, wildfire 21–30, cutblock 31–40, wildfire 31–40, caribou use >40. The development of the disturbance class variable enabled us to compare all age classes of the cutblock and wildfire sites to the caribou use sites (caribou use sites all >40 years). We included disturbance class as a factor in all GLMs, with ‘caribou use >40’ as the reference category.

Normality of the response variables was confirmed based on the residuals of the models, significance was considered at $\alpha = 0.05$, and all analyses were performed using R v. 4.1.3 software.

3.2.2. Relationships between stand characteristics and forage groups among sites

3.2.2.1. Stand characteristics as predictor variables

Wildlife forage is influenced by stand characteristics, which in turn influences wildlife use (Nadeau Fortin et al. 2016; Souliere et al. 2020; McKay and Finnegan 2023). Therefore, we investigated stand characteristic-forage availability relationships. We included stand composition and structure variables as predictors in our analysis of the forage groups. We selected the stand attributes basal area (BA), deciduous basal area (BA.d), canopy cover, and counts of coniferous saplings (Table 2.1). These overstory characteristics can influence light availability and subsequent abundance of understory vegetation, such as shrubs, forbs, and terrestrial lichens (Greene et al. 1999; Ilisson and Chen 2009; Bergqvist et al. 2018). We also included downed CWD (dCWD) and soil depth in our models (Table 2.1). Since the basal area measurements included snags and stumps, for this analysis we focused on downed CWD. CWD takes up space on the ground, which can limit resources for vascular plants and some terrestrial lichens (McRae et al. 2001). The depth of the organic layer of soil can affect the composition and abundance of understory vegetation (Estrada-Villegas et al. 2020). Greater soil depth typically contains more nutrients and can hold more moisture, reflecting productive growing conditions for vascular plants (Coxson and Marsh 2001; Rajakaruna and Boyd 2008). We included time since disturbance/stand age of sites in models. For cutblock and wildfire sites, we determined time since disturbance using data from the Government of Alberta. For caribou use sites, we calculated stand age using dendrochronology data from tree core samples. If tree cores were not sampled, we used Alberta Vegetation Inventory (AVI) data to determine stand age.

3.2.2.2. Data analysis

We used negative binomial count models (GLM, link = log) to predict abundance of forage for caribou, moose, and bears. We built separate count models for each site type (cutblock, wildfire, caribou use), which allowed us to compare stand attributes influencing forage abundance among site types. We used stand characteristics from field data (described in section 1.3.2; Table 2.1) to construct initial candidate models. Main effects in initial models were basal area (BA), deciduous basal area (BA.d), canopy cover, coniferous saplings, downed CWD, soil depth, time since disturbance, and the factor NSR. Due to insufficient sample sizes for some strata (e.g., 0 caribou use sites in the Lower Foothills), we combined data for the Lower and Upper Foothills NSRs. We also included interactions considered ecologically important in affecting abundance of the forage groups (Table 1.5; Natural Regions Committee, 2006). However, to avoid multicollinearity and maintain model tractability we limited interactions to basal area x soil depth, basal area x NSR, deciduous basal area x NSR, and canopy cover x NSR. The inclusion of the NSR-interactions helped control for any regional variation in ecosystem subtype (Natural Regions Committee, 2006). We used variance inflation factors (VIF) to test predictor variables for multicollinearity (tolerance < 6). We employed deviation coding for all predictor parameters containing the factor NSR.

We used the 'dredge' function for model selection ("MuMIn" package, Barton 2022) and Akaike information criterion corrected for small sample size (AIC*c*) to determine the most parsimonious models (Burnham and Anderson 2002). We considered all models with a ΔAIC*c* < 2.0 to be equally parsimonious and included all predictor variables from these models in the final model for each forage group. We used the root mean square error (RMSE) and coefficient of determination (R^2) to assess the predictive ability of the most parsimonious models. Predicted scores were generated with a 20-fold cross-validation ("caret" package, Kuhn 2008). To plot interactions from final models, we calculated predicted values of abundance using the emmip function ("emmeans" package, Lenth 2023). We considered results statistically significant at $\alpha = 0.05$. All statistical analyses were performed using R v. 4.1.3.

3.3. Results

3.3.1. Comparison of stand characteristics among sites

In most NSRs, stand basal area, QMD, SPH, and canopy cover increased through time following timber harvest or wildfire, and approached or exceeded the values observed in caribou use sites by 31–40 years post-disturbance (Figures 3.1, 3.2, 3.3). In the Central Mixedwood, and Lower and Upper Boreal Highlands, basal area, QMD, SPH, and canopy cover generally increased more quickly in cutblocks compared to wildfire sites (Figures 3.1, 3.3). Stand structural characteristics exhibited similar recovery trends across the four NSRs (Figure 3.1). Cutblocks typically achieved a basal area of 20 m^2 ha^{-1} or greater as early as 21 years post-harvest, with basal area being slightly less in the Lower and Upper Boreal Highlands. In wildfire sites, the development time for basal area, QMD, and canopy cover generally took longer; up to 31–40 years post-wildfire to reach comparable values in similarly-aged cutblocks and older caribou use sites (Figures 3.1, 3.2). Considering stand composition, deciduous basal area was generally low in caribou use sites in the Foothills, and Lower and Upper Boreal Highlands (Table 3.1). Deciduous basal area was generally greater in cutblocks compared to wildfire sites, and by 21–30 years post-disturbance values were greater in cutblocks compared to caribou use sites (Figure 3.1). In the Foothills, we did not observe any deciduous trees in the wildfire sites 11–20, 21–30, 31—40 years post-disturbance (Figure 3.1). Counts of coniferous saplings were greater in early wildfire sites compared to cutblock and caribou use sites (Figures 3.3, 3.4). Soil depth was greater in caribou use sites compared to recently disturbed cutblock and wildfire sites (Figure 3.3, 3.4).

Coarse woody debris was generally more abundant in the wildfire sites compared to cutblock and caribou use sites until at least 20 years post-disturbance (Figures 3.3, 3.4). In all NSRs, wildfire resulted in high initial amounts of CWD which then decreased over time, and by 31–40 years post-disturbance CWD in wildfire sites was similar to amounts in cutblock and caribou use sites (Figure 3.4).

For caribou forbs, we did not observe clear patterns among site types in any NSR (Figure 3.5, 3.8). Caribou lichen abundance was low in both recent cutblocks and wildfire sites across NSRs (Figure 3.5). Caribou lichens were less abundant in cutblock and wildfire sites compared to caribou use sites until at least 11–20 years post-disturbance (Figures 3.5, 3.8). Caribou lichens were generally more abundant in wildfire sites compared to cutblock sites by 11–20 years post-disturbance (Figure 3.5).

Compared to caribou use sites, moose forbs were more abundant in early cutblock and wildfire sites (0–20 years post-disturbance) in the Upper Boreal Highlands, and in recent cutblocks in the Foothills (Figures 3.6, 3.8). In all NSRs, moose saplings were generally less frequent in caribou use sites than in cutblock and wildfire sites (Figures 3.6, 3.8). Moose saplings decreased with increased time since disturbance in cutblock and wildfire sites (Figure 3.6). Moose shrub abundance was generally greater in cutblocks compared to caribou use sites across NSRs (Figure 3.6, 3.8). Moose shrubs were also more abundant in wildfire sites than caribou use sites in the Central Mixedwood and Upper Boreal Highlands (Figures 3.6, 3.8).

Bear forbs did not differ among NSR or site type (Figures 3.7, 3.8). Bear shrubs were more abundant in cutblock sites when compared to caribou use sites in the Central Mixedwood and Foothills, irrespective of time since disturbance (Figures 3.7, 3.8). Abundance of bear shrubs was generally greater in cutblocks than wildfire sites across NSRs (Figure 3.7). Bear shrubs were not observed in caribou use sites in the Upper Boreal Highlands preventing statistical comparison with disturbance type.

Complete model results are in the Appendix (Tables A6 – A20).

3.3.1. Figures

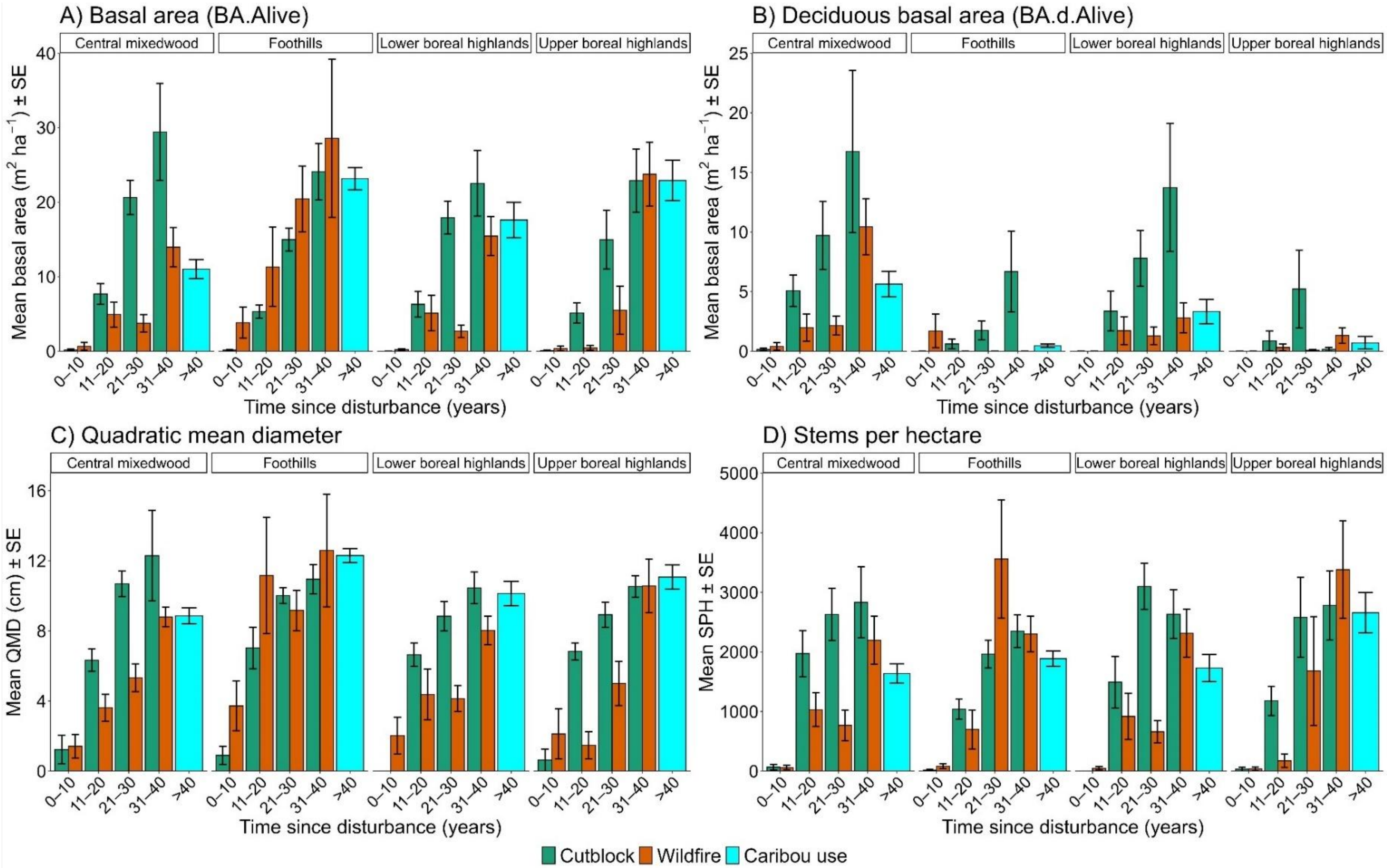

Figure 3.1. Mean values of stand characteristics A) Basal area (BA.Alive), B) Deciduous basal area (BA.d.Alive), C) Quadratic mean diameter (QMD), and D) Stems per hectare (SPH) compared between disturbance type and time since disturbance across natural subregions. Error bars represent standard error (SE) of the mean. Both mean and SE were calculated from the raw data.

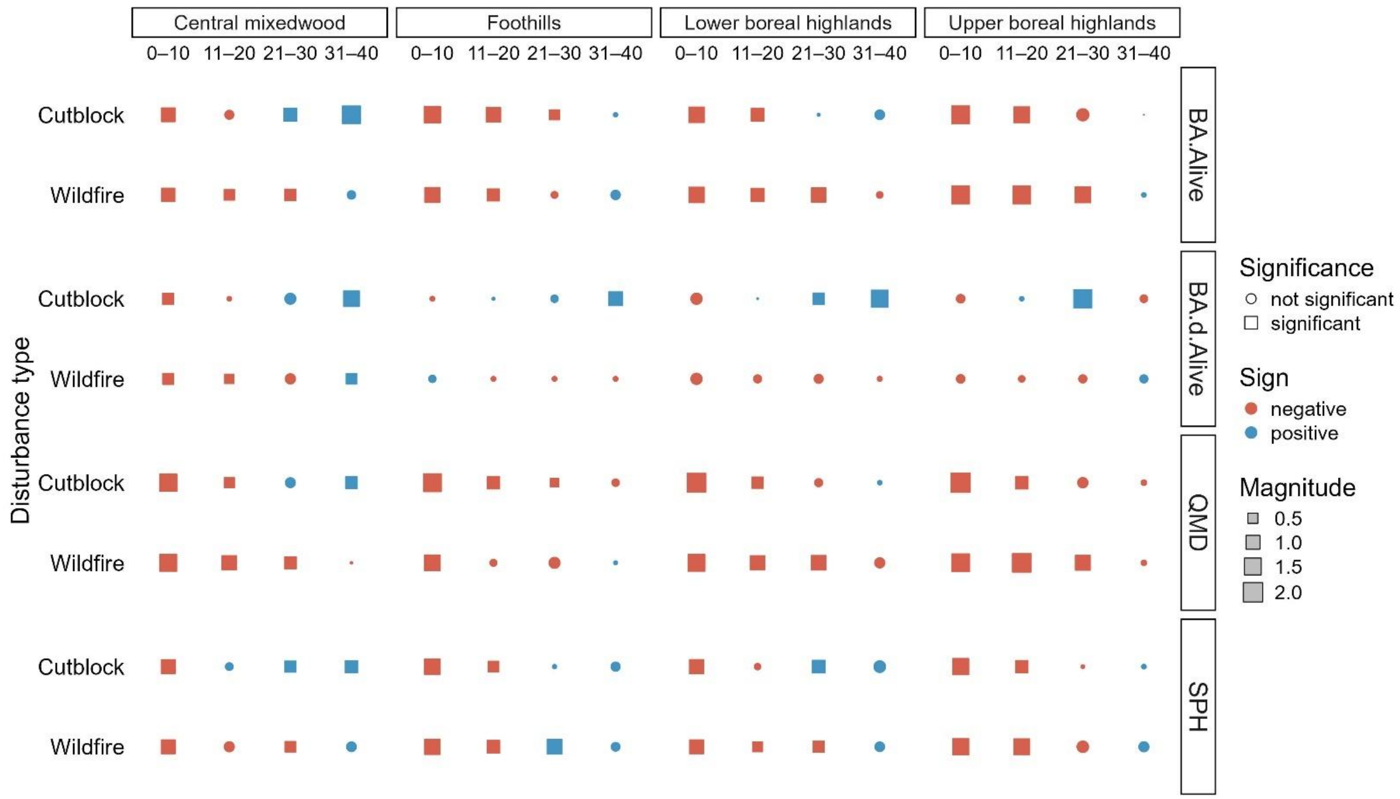

Figure 3.2. Magnitude and significance of coefficients representing the effect of disturbance type and time since disturbance (disturbance class) on stand characteristics (timber supply metrics) according to natural subregions (Central Mixedwood, Foothills, Lower Boreal Highlands, Upper Boreal Highlands). Reference category is strata 'Caribou use >40 years.' BA.Alive = basal area (alive trees), BA.d.Alive =deciduous basal area (alive trees), QMD = quadratic mean diameter, SPH = stems per hectare. Numbers below strips at top of figure refer to time since disturbance (in years). Circles represent non-significant effects, squares represent significant effects. Red and blue symbols indicate negative and positive coefficient estimates, respectively. Size of symbol represents the magnitude of the coefficient estimate. Coefficient estimates and corresponding p-values were derived from GLMs (Tables A6–A9).

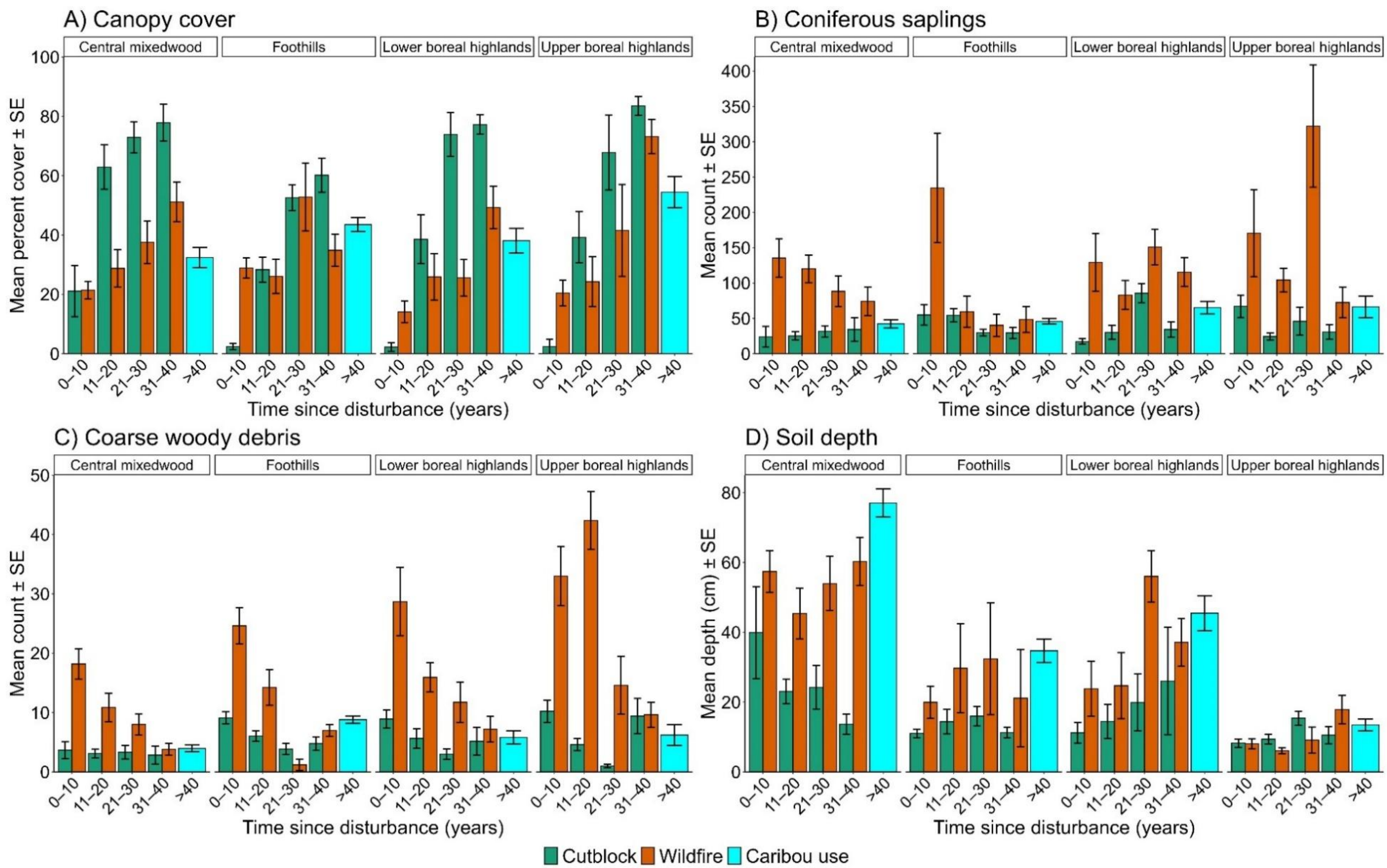

Figure 3.3. Mean values of stand characteristics A) Canopy cover, B) Coniferous saplings (count), C) Coarse woody debris (CWD), and D) Soil depth compared between disturbance type and time since disturbance across natural subregions. Error bars represent standard error (SE) of the mean. Both mean and SE were calculated from the raw data.

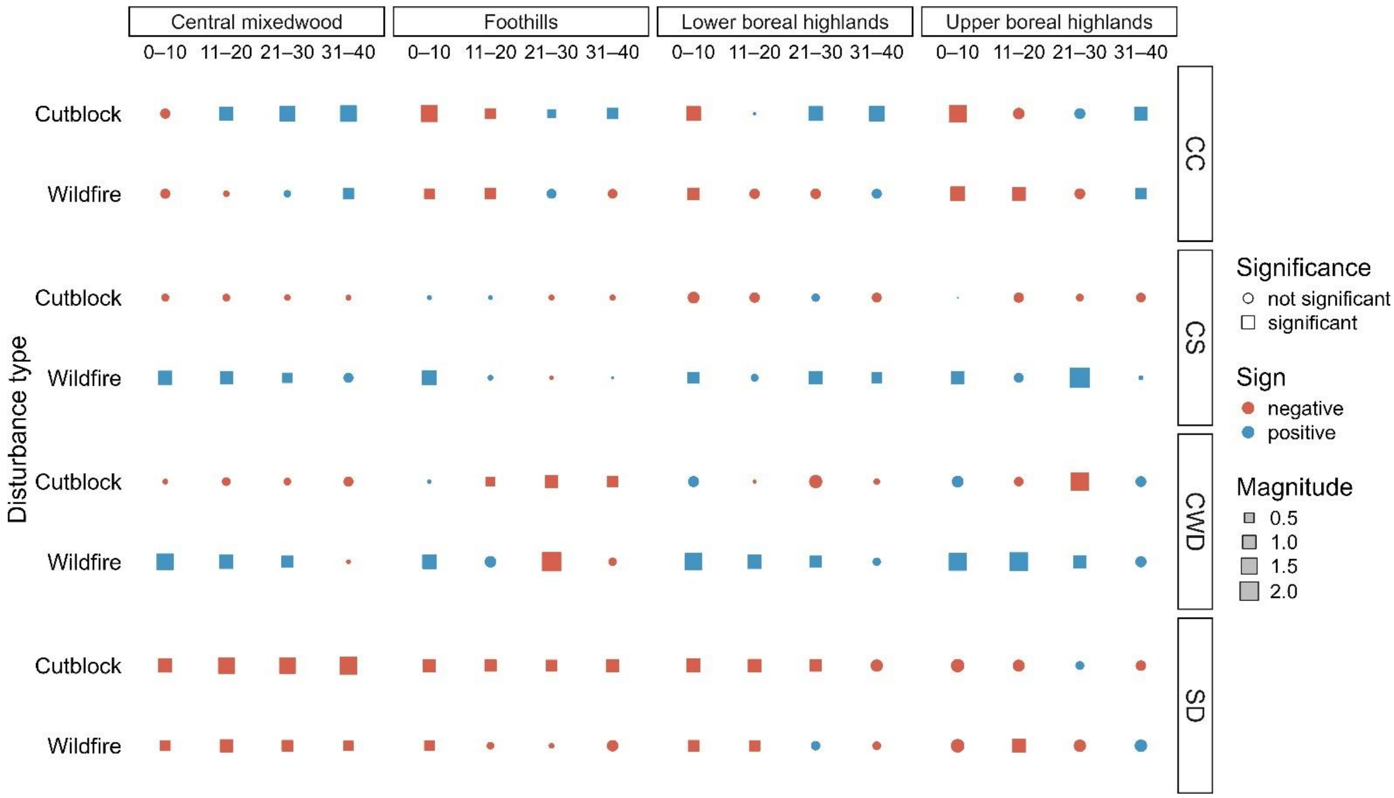

Figure 3.4. Magnitude and significance of coefficients representing the effect of disturbance type and time since disturbance (disturbance class) on stand characteristics according to natural subregions (Central Mixedwood, Foothills, Lower Boreal Highlands, Upper Boreal Highlands). Reference category is strata 'Caribou use >40 years.' CC = canopy cover, CS = coniferous saplings, CWD = coarse woody debris (including snags and stumps), SD = soil depth. Numbers below strips at top of figure refer to time since disturbance (in years). Circles represent non-significant effects, squares represent significant effects. Red and blue symbols indicate negative and positive coefficient estimates, respectively. Size of symbol represents the magnitude of the coefficient estimate. Coefficient estimates and corresponding p-values were derived from GLMs (Tables A10–A13).

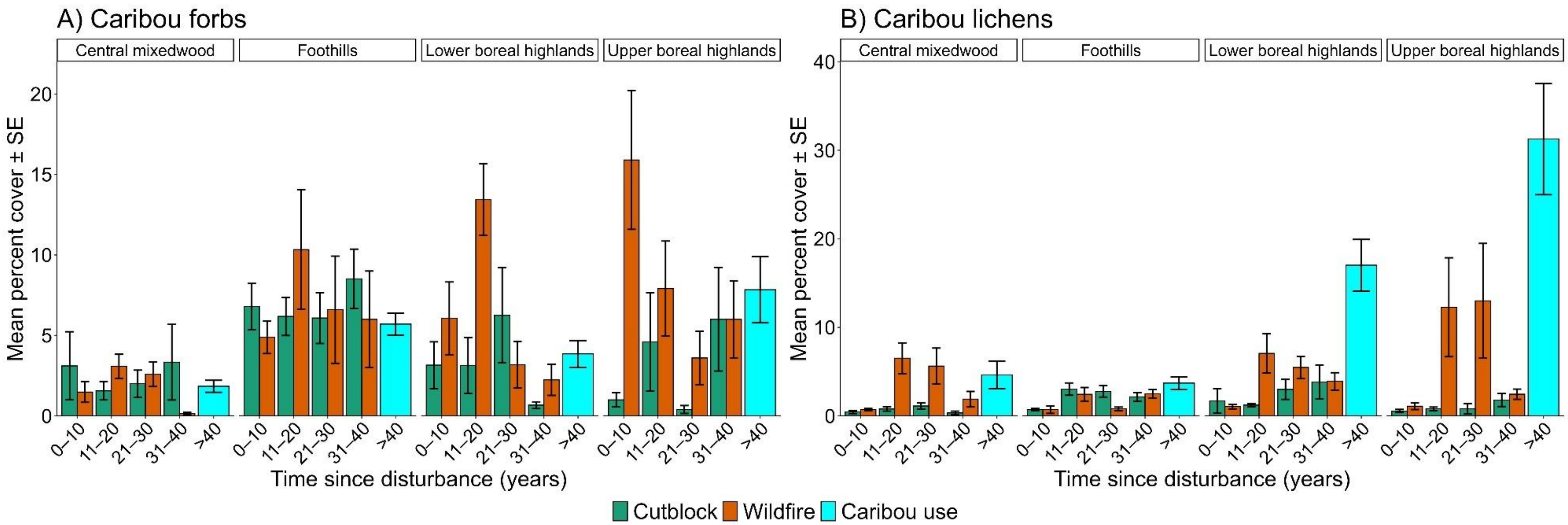

Figure 3.5. Mean values of forage groups A) Caribou forbs, and B) Caribou lichens compared between disturbance type and time since disturbance across natural subregions. Error bars represent standard error (SE) of the mean. Both mean and SE were calculated from the raw data.

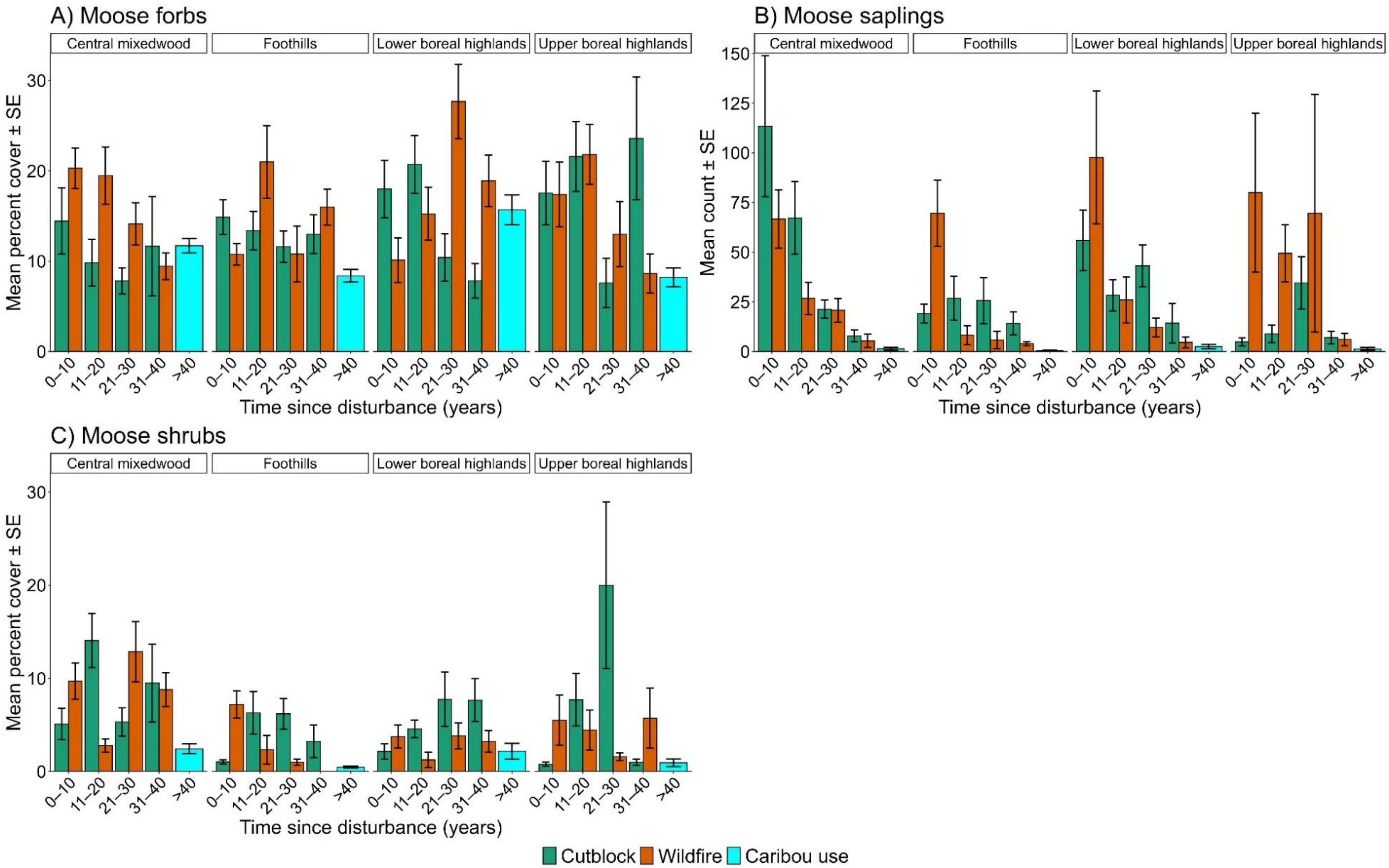

Figure 3.6. Mean values of forage groups A) Moose forbs, B) Moose saplings, and C) Moose shrubs compared between disturbance type and time since disturbance across natural subregions. Error bars represent standard error (SE) of the mean. Both mean and SE were calculated from the raw data.

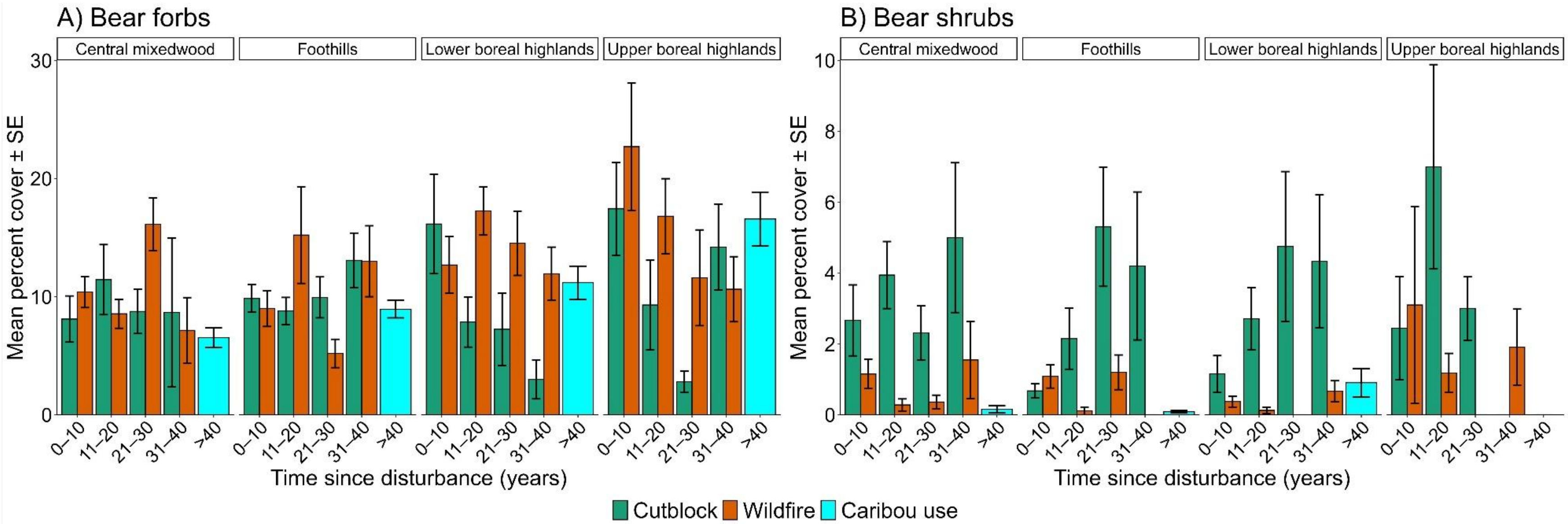

Figure 3.7. Mean values of forage groups A) Bear forbs, and B) Bear shrubs compared between disturbance type and time since disturbance across natural subregions. Bear shrubs were not observed in 'Wildfire 31–40' strata in Foothills, 'Wildfire 21–30' strata in Lower Boreal Highlands, and caribou use sites in Upper Boreal Highlands. Error bars represent standard error (SE) of the mean. Both mean and SE were calculated from the raw data.

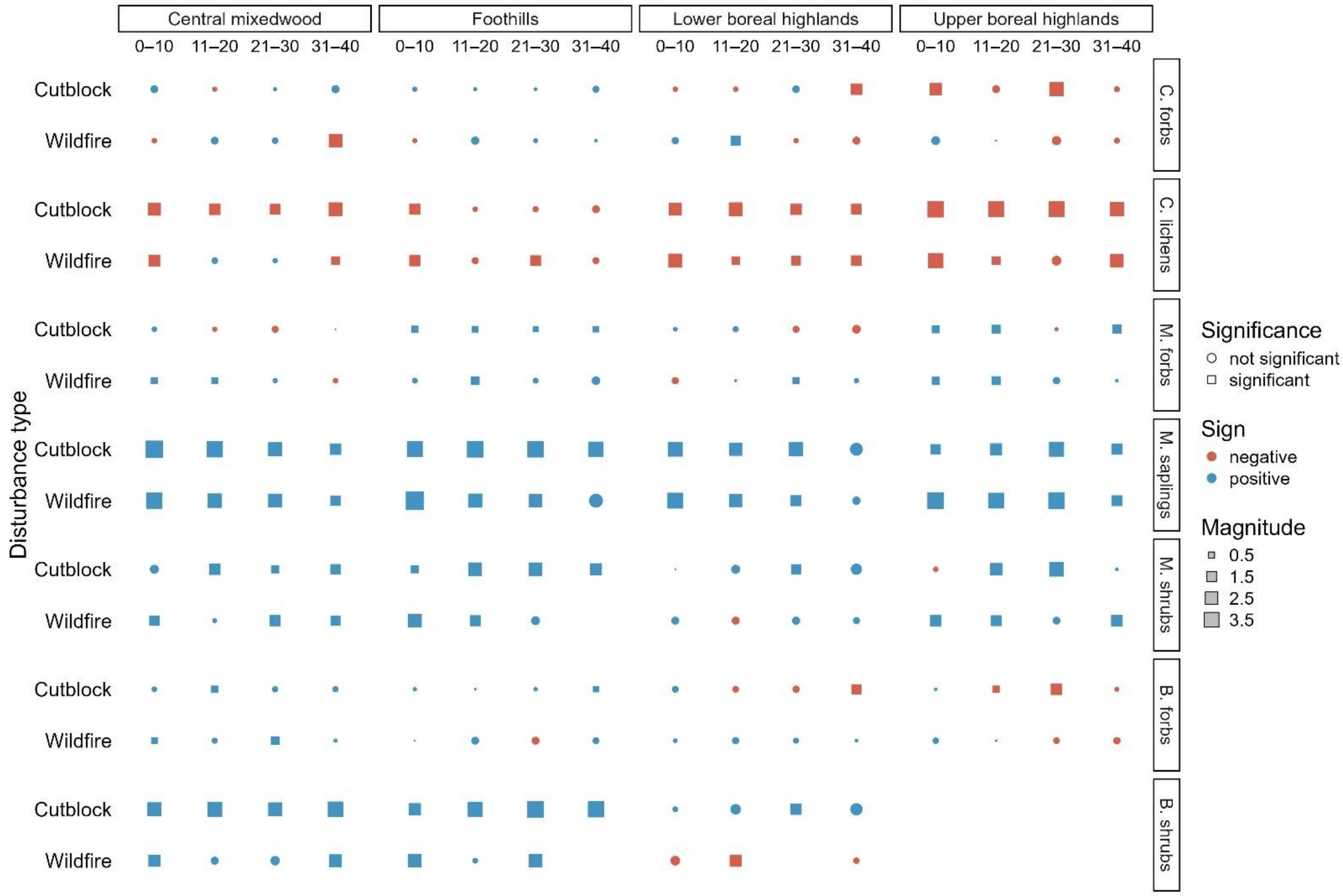

Figure 3.8. Magnitude and significance of coefficients representing the effect of disturbance type and time since disturbance (disturbance class) on forage groups according to natural subregions (Central Mixedwood, Foothills, Lower Boreal Highlands, Upper Boreal Highlands). Reference category is strata 'Caribou use >40 years.' C. forbs = caribou forbs, C. lichens = caribou lichens, M. forbs = moose forbs, M. saplings = moose saplings, M. shrubs = moose shrubs, B. forbs = bear forbs, B. shrubs = bear shrubs; Numbers below strips at top of figure refer to time since disturbance (in years). Circles represent non-significant effects, squares represent significant effects. Red and blue symbols indicate negative and positive coefficient estimates, respectively. Size of symbol represents the magnitude of the coefficient estimate. Coefficient estimates and corresponding p-values were derived from GLMs (Tables A14–A20). Moose shrubs (M. shrubs) did not occur in 'Wildfire 31–40' strata in Foothills, and Bear shrubs (B. shrubs) did not occur in 'Wildfire 31–40' strata in Foothills, 'Wildfire 21–30' strata in Lower Boreal Highlands, and reference category sites (Caribou use >40) in Upper Boreal Highlands, therefore the respective coefficient estimates were omitted.

3.3.2. Relationships between stand characteristics and forage groups among sites

Caribou forage

In cutblock sites, the abundance of caribou forbs decreased with greater basal area in all NSRs except for the Central Mixedwood (Figures 3.9). Caribou forbs decreased with greater canopy cover in cutblock sites in the Central Mixedwood and Foothills, and increased with greater canopy cover in the Lower and Upper Boreal Highlands (Figure 3.10). Caribou forbs increased with greater time since disturbance in cutblock sites (Figure 3.9). In wildfire sites, an increase in deciduous basal area had a negative effect on caribou forbs (Figure 3.9). In caribou use sites, caribou forbs increased with greater basal area in all NSRs except for the Foothills (Figure 3.10). In caribou use sites, greater deciduous basal area had a positive effect on caribou forbs in the Central Mixedwood, and a negative effect in the Foothills (Figure 3.10). In all sites, caribou forbs were less abundant in areas with greater soil depth (Figure 3.9). Based on cross validation, final models for cutblock, wildfire, and caribou use sites explained 19.7%, 30.8%, and 31.9% of the observed variability of caribou forbs, respectively (Figure A6).

There were fewer forage lichens for caribou in cutblock sites with greater amounts of basal area and deciduous basal area (Figure 3.9). In both cutblock and wildfire sites, caribou lichens increased with greater time since disturbance (Figure 3.9). In wildfire sites, caribou lichens were negatively affected by basal area in the lower and Upper Boreal Highlands, and positively affected by basal area in the Central Mixedwood (Figure 3.11). In wildfire sites, caribou lichens decreased with greater canopy cover in the Central Mixedwood but increased with greater canopy cover in the Foothills (Figure 3.11). In all sites, caribou lichens decreased with greater soil depth (Figure 3.9). Final models for cutblock, wildfire, and caribou use sites explained 23.0%, 30.9%, and 47.7% of the observed variability of caribou lichens, respectively (Figure A7).

Moose forage

Moose forbs were more abundant in cutblock sites in the Central Mixedwood with greater basal area but were less abundant in cutblock sites with greater deciduous basal area (Figures 3.9, 3.12). In cutblock sites, moose forbs decreased with greater canopy cover in the Central Mixedwood and increased with greater canopy cover in the Upper Boreal Highlands (Figure 3.12). In wildfire sites, moose forbs decreased with greater counts of coniferous saplings and decreased with greater canopy cover in all NSRs except for the Foothills (Figures 3.9, 3.12). Conversely, soil depth had a positive effect on moose forbs in wildfire sites (Figure 3.9). In caribou use sites, basal area had a negative effect on moose forbs (Figure 3.9). However, at a greater soil depth in caribou use sites, moose forbs increased with greater basal area (Figure A8). Final models for cutblock, wildfire, and caribou use sites explained 14.4%, 23.9%, and 34.5% of the observed variability of moose forbs, respectively (Figure A9).

Moose saplings were less abundant as basal area increased in cutblock sites (Figures 3.9, 3.13). In cutblock sites, moose saplings were positively and negatively affected by canopy cover in the Upper Boreal Highlands and the Central Mixedwood NSRs, respectively (Figure 3.13). In contrast, canopy cover had a positive effect on moose saplings in the Lower Boreal Highlands, and a negative effect in the Foothills in wildfire sites (Figure 3.13). Moose saplings decreased with time since disturbance in cutblock and wildfire sites and increased with greater deciduous basal area in wildfire sites (Figure 3.9). Coniferous saplings had a positive effect on moose saplings in cutblock sites, and a negative effect in caribou use sites (Figure 3.9). In caribou use sites in the Lower Boreal Highlands, moose saplings increased with greater basal area (Figure 3.13). In all sites, soil depth had a negative effect on moose saplings (Figure 3.9). However, with greater soil depth in caribou use sites, moose saplings increased with greater basal area (Figure A8). Final models for cutblock, wildfire, and caribou use sites explained 28.0%, 34.5%, and 23.9% of the observed variability of moose saplings, respectively (Figure A10).

In cutblock sites, moose shrubs were negatively associated with basal area, coniferous saplings, and CWD, and positively associated with deciduous basal area and canopy cover (Figure 3.9). In wildfire sites, moose shrubs increased with greater basal area in the Lower Boreal Highlands and increased with greater deciduous basal area in the Upper Boreal Highlands (Figure 3.14). Moose shrubs decreased with time since disturbance in wildfire sites, and increased with greater soil depth in caribou use sites (Figure 3.9). In caribou use sites in the Lower Boreal Highlands, canopy cover had a negative effect on moose shrubs (Figure 3.14). Final models for cutblock, wildfire, and caribou use sites explained 34.4%, 23.5%, and 17.1% of the observed variability of moose shrubs, respectively (Figure A11).

Bear forage

Bear forbs were less abundant in cutblock sites with greater deciduous basal area (Figure 3.9). In wildfire sites, deciduous basal area had a positive effect on bear forbs in the Foothills, and a negative effect in the Upper Boreal Highlands (Figure 3.15). Canopy cover and coniferous saplings had negative effects on bear forbs in wildfire sites (Figure 3.9). Bear forbs increased in wildfire and caribou use sites with greater basal area at greater soil depths (Figure A12). In caribou use sites in the Foothills, bear forbs were positively affected by basal area (Figure 3.15). Conversely, CWD had a negative effect on bear forbs in caribou use sites (Figure 3.9). Canopy cover also had a negative effect on bear forbs in caribou use sites in the Lower Boreal Highlands (Figure 3.15). Final models for cutblock, wildfire, and caribou use sites explained 9.0%, 18.3%, and 30.7% of the observed variability of bear forbs, respectively (Figure A13).

Bear shrubs were not observed in caribou use sites in the Upper Boreal Highlands, so data from the Lower Boreal Highlands and Upper Boreal Highlands were combined for the analysis of this forage group. Bear shrubs were less abundant in cutblock and wildfire sites with greater basal area, except for wildfire sites in the boreal highlands where bear shrubs increased with greater basal area (Figures 3.9, 3.16). In cutblock and wildfire sites, bear shrubs were positively associated with deciduous basal area and canopy cover (Figure 3.9). Bear shrubs decreased with time since disturbance in cutblock and wildfire sites, and decreased with greater counts of coniferous saplings in all site types (Figure 3.9). At greater soil depths in wildfire and caribou use sites, bear shrubs increased with greater basal area (Figure A12). Conversely, canopy cover had a negative effect on bear shrubs in caribou use sites in the boreal highlands (Figure 3.16). Final models for cutblock, wildfire, and caribou use sites explained 30.7%, 24.4%, and 63.7% of the observed variability of bear shrubs, respectively (Figure A14).

Complete model results are in the Appendix (Tables A21 – A27).

3.3.2. Figures

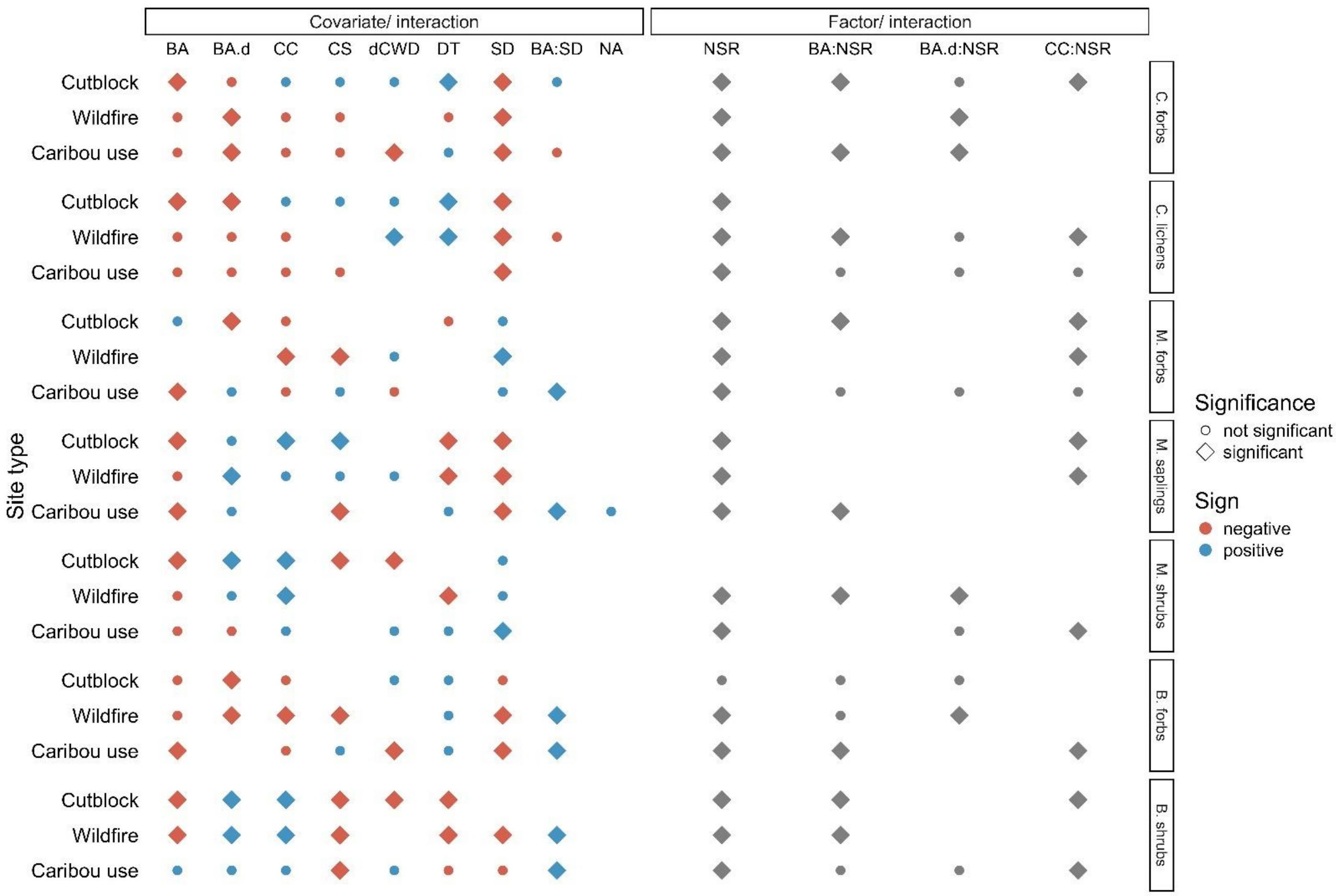

Figure 3.9. Summary of final models for each forage group and for each site type (cutblock, wildfire, caribou use). Circles represent non-significant parameters; diamonds represent significant parameters. Red and blue symbols indicate negative and positive effects, respectively. Categorical parameters (factors) and interactions with factors are expressed in grey. Factors and interactions with factors were considered significant if at least one category was significant. Blank spaces indicate that a parameter was not included in the final model. Covariates: BA = basal area (all status), BA.d = deciduous basal area (all status), CC = canopy cover, CS = coniferous saplings, dCWD = downed coarse woody debris, DT = time since disturbance, SD = soil depth; factor: NSR = natural subregion. ":" indicates an interaction between parameters. Results were generated from negative binomial GLMs. Please refer to Appendix: Tables A21–A27 for the coefficient results for each final model.

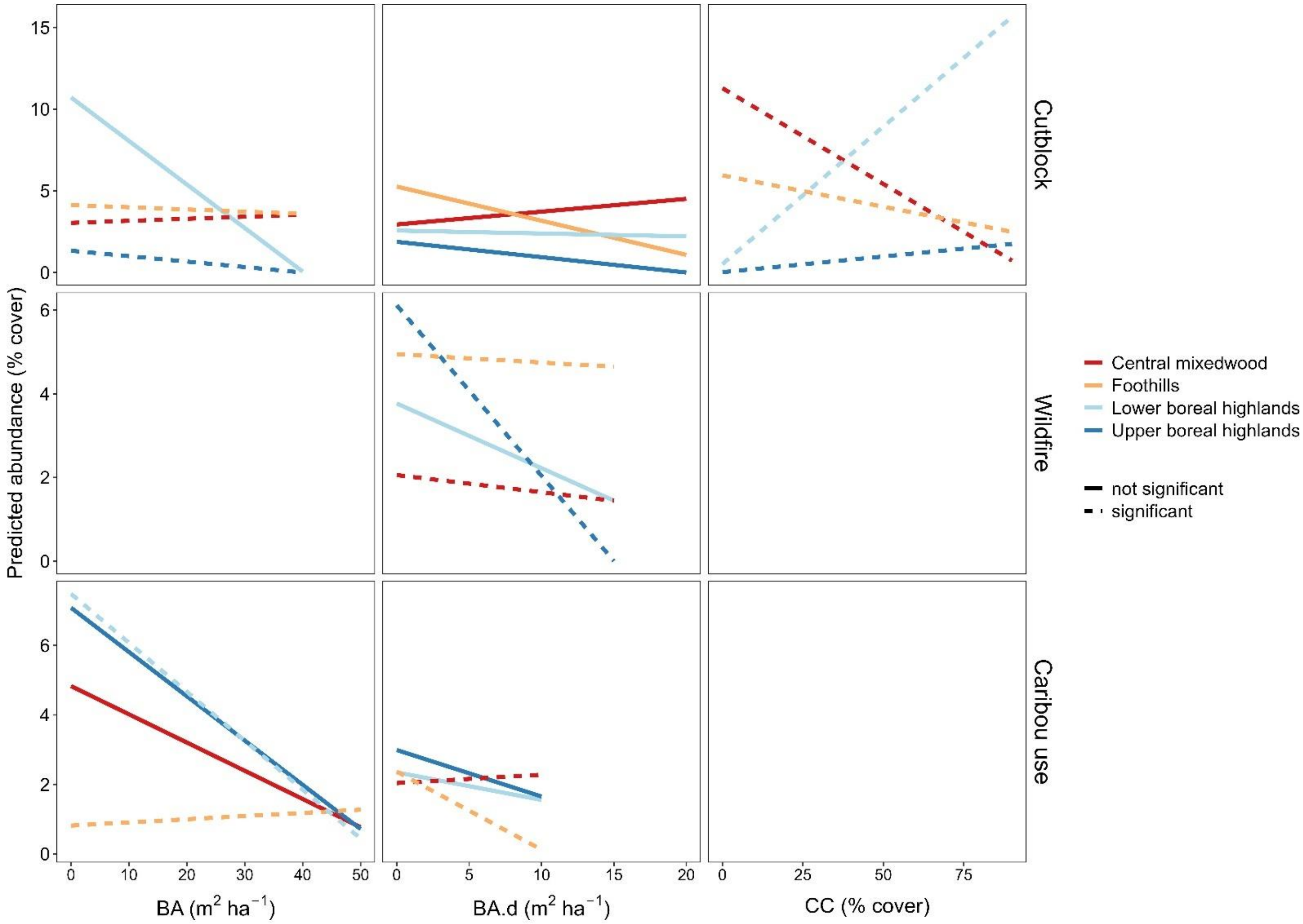

Figure 3.10. Predicted abundance of ***caribou forbs*** *(% cover) based on interactions between NSR (natural subregion) and covariates: basal area (BA), deciduous basal area (BA.d), and canopy cover (CC). Mapping of figure panels corresponds to mapping of interactions in Figure 2; blank panels represent interaction not included in final model (Figure 2). Red lines represent Central Mixedwood, orange for Foothills, light blue for Lower Boreal Highlands, and dark blue for Upper Boreal Highlands. Solid lines indicate non-significant effects, dashed lines indicate significant effects.*

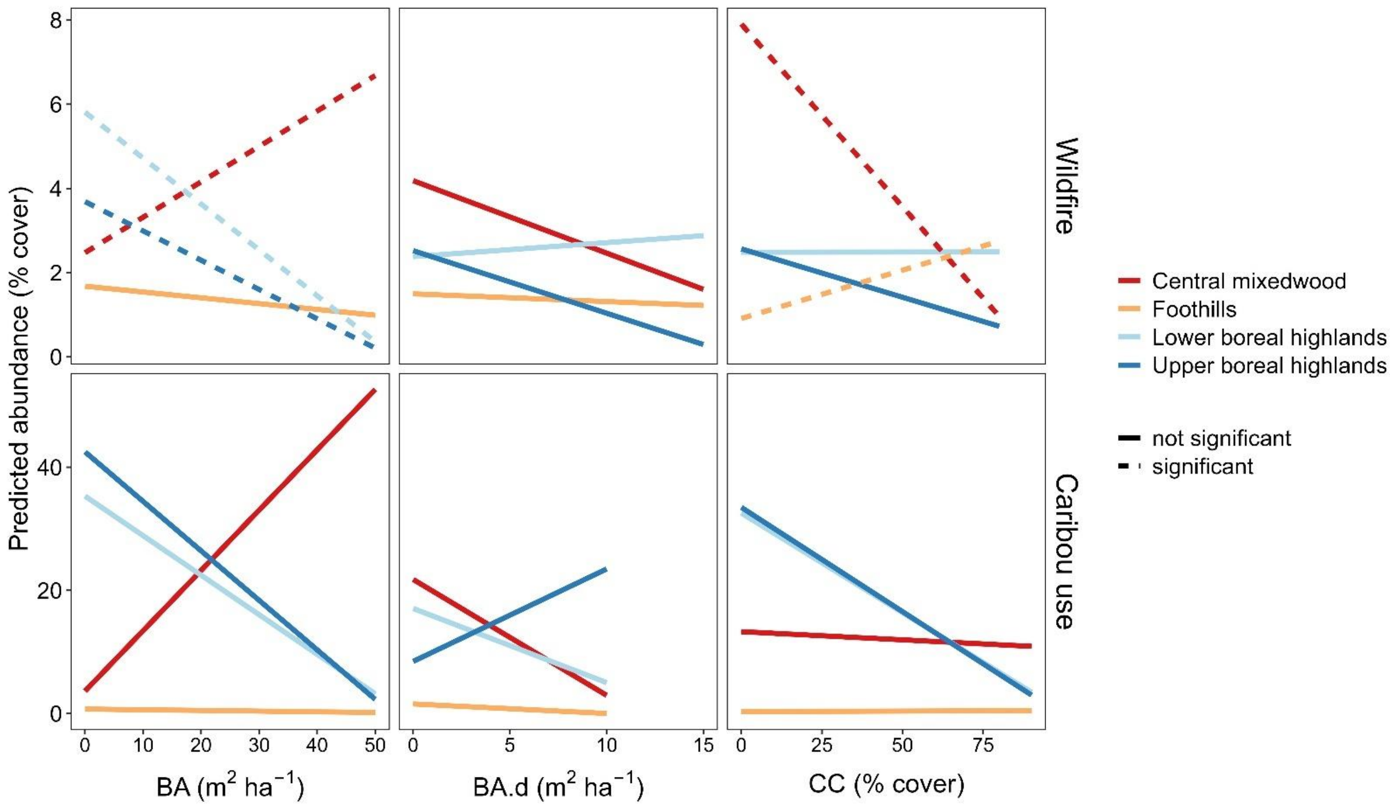

Figure 3.11. Predicted abundance of ***caribou lichens*** *(% cover) based on interactions between NSR (natural subregion) and covariates: basal area (BA), deciduous basal area (BA.d), and canopy cover (CC). Mapping of figure panels corresponds to mapping of interactions in Figure 2. Red lines represent Central Mixedwood, orange for Foothills, light blue for Lower Boreal Highlands, and dark blue for Upper Boreal Highlands. Solid lines indicate non-significant effects, dashed lines indicate significant effects.*

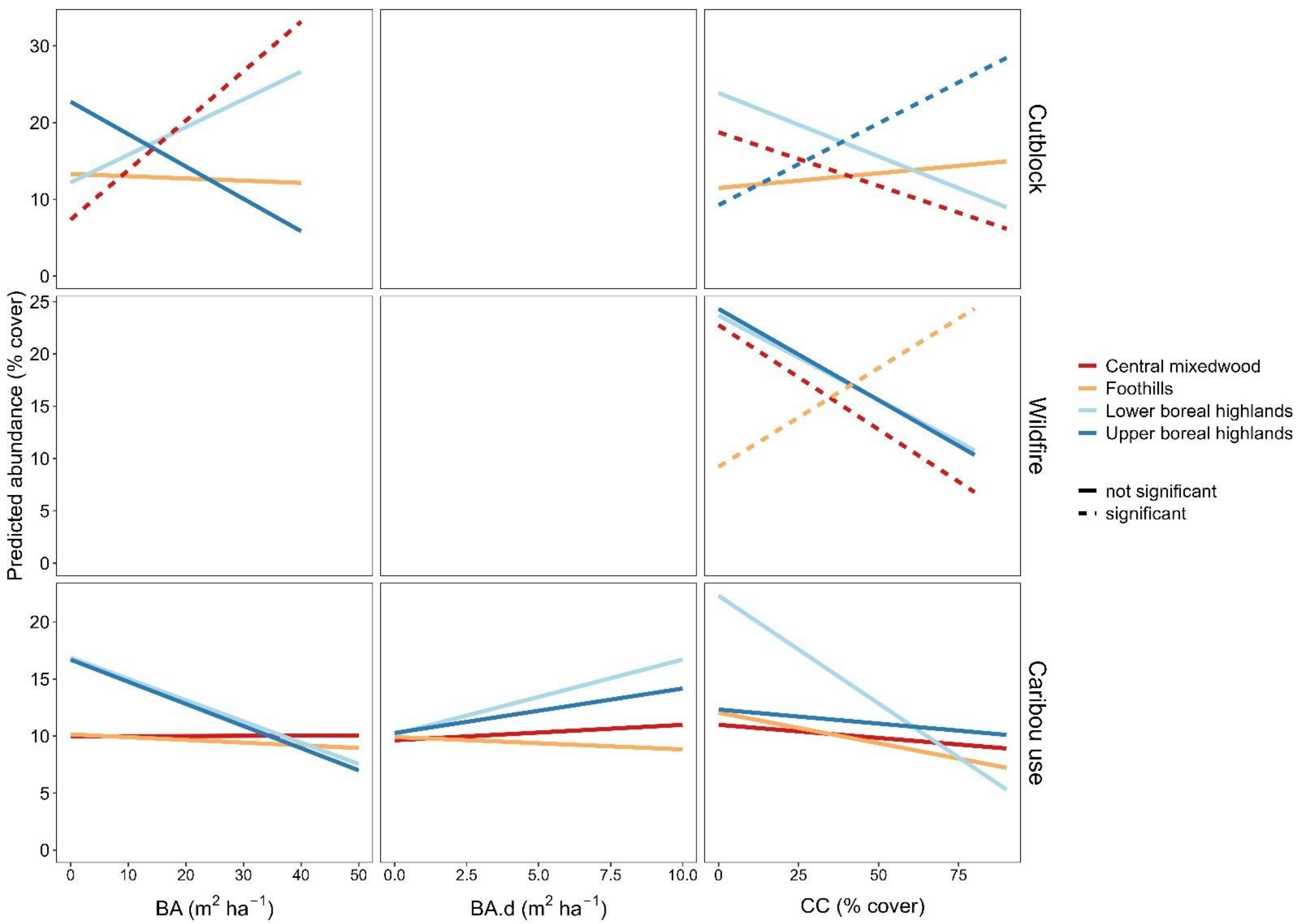

Figure 3.12. Predicted abundance of ***moose forbs*** *(% cover) based on interactions between NSR (natural subregion) and covariates: basal area (BA), deciduous basal area (BA.d), and canopy cover (CC). Mapping of figure panels corresponds to mapping of interactions in Figure 2; blank panels represent interaction not included in final model (Figure 2). Red lines represent Central Mixedwood, orange for Foothills, light blue for Lower Boreal Highlands, and dark blue for Upper Boreal Highlands. Solid lines indicate non-significant effects, dashed lines indicate significant effects.*

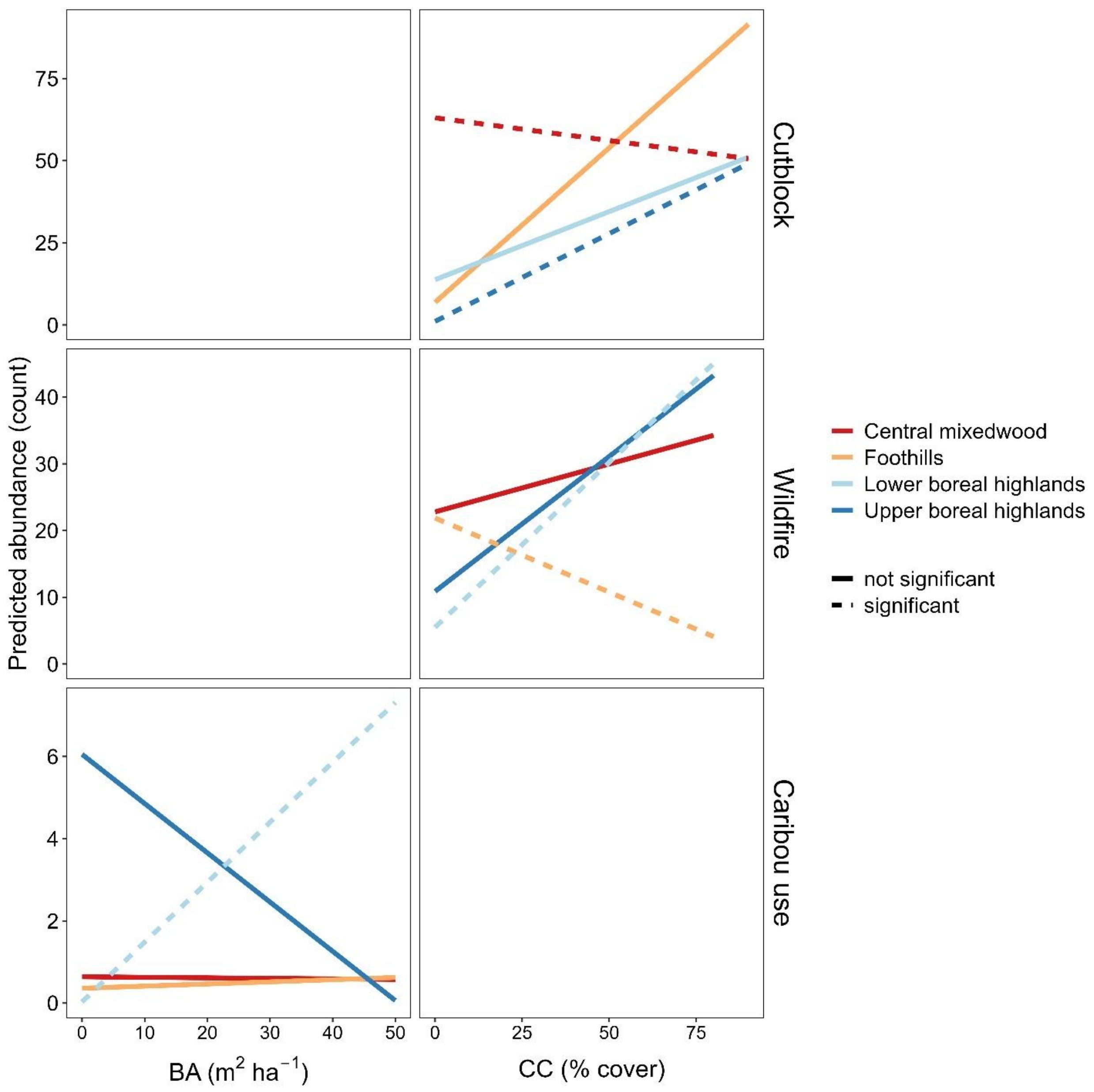

*Figure 3.13. Predicted abundance of **moose saplings** (count) based on interactions between NSR (natural subregion) and covariates: basal area (BA), and canopy cover (CC). Mapping of figure panels corresponds to mapping of interactions in Figure 2; blank panels represent interaction not included in final model (Figure 2). No NSR x Deciduous basal area interactions were included in any final model for moose saplings. Red lines represent Central Mixedwood, orange for Foothills, light blue for Lower Boreal Highlands, and dark blue for Upper Boreal Highlands. Solid lines indicate non-significant effects, dashed lines indicate significant effects.*

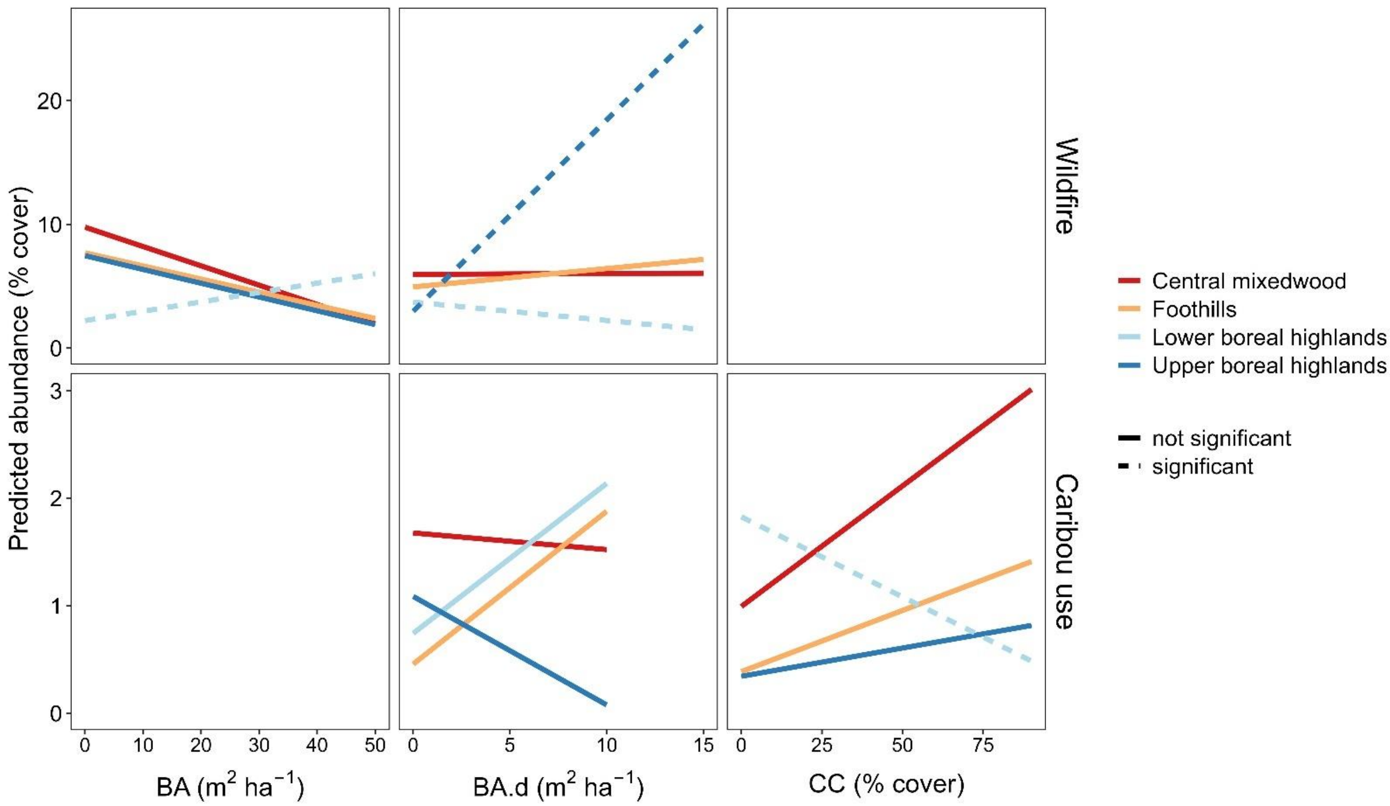

*Figure 3.14. Predicted abundance of **moose shrubs** (% cover) based on interactions between NSR (natural subregion) and covariates: basal area (BA), deciduous basal area (BA.d), and canopy cover (CC). Mapping of figure panels corresponds to mapping of interactions in Figure 2; blank panels represent interaction not included in final model (Figure 2). Red lines represent Central Mixedwood, orange for Foothills, light blue for Lower Boreal Highlands, and dark blue for Upper Boreal Highlands. Solid lines indicate non-significant effects, dashed lines indicate significant effects.*

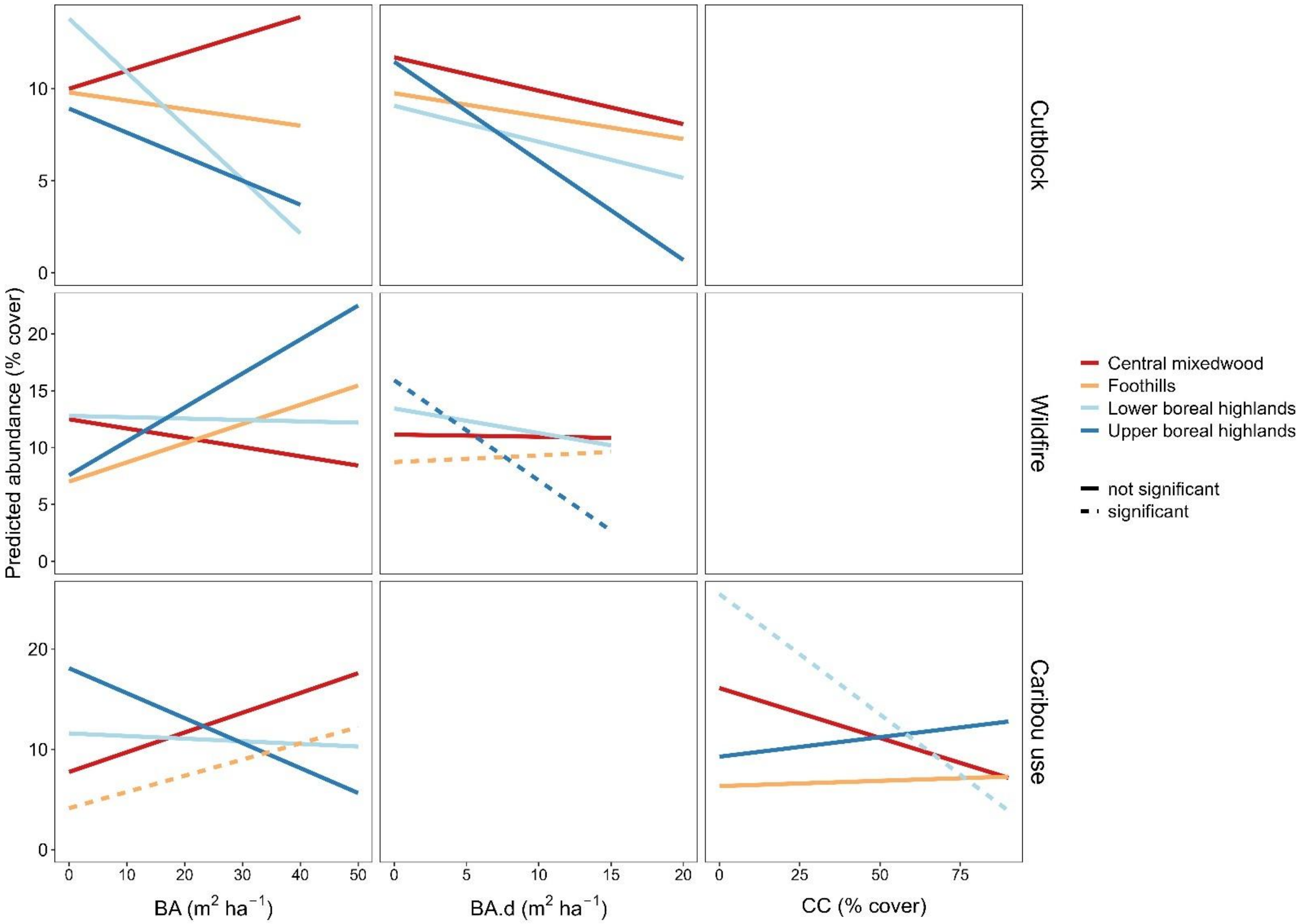

*Figure 3.15. Predicted abundance of **bear forbs** (% cover) based on interactions between NSR (natural subregion) and covariates: basal area (BA), deciduous basal area (BA.d), and canopy cover (CC). Mapping of figure panels corresponds to mapping of interactions in Figure 2; blank panels represent interaction not included in final model (Figure 2). Red lines represent Central Mixedwood, orange for Foothills, light blue for Lower Boreal Highlands, and dark blue for Upper Boreal Highlands. Solid lines indicate non-significant effects, dashed lines indicate significant effects.*

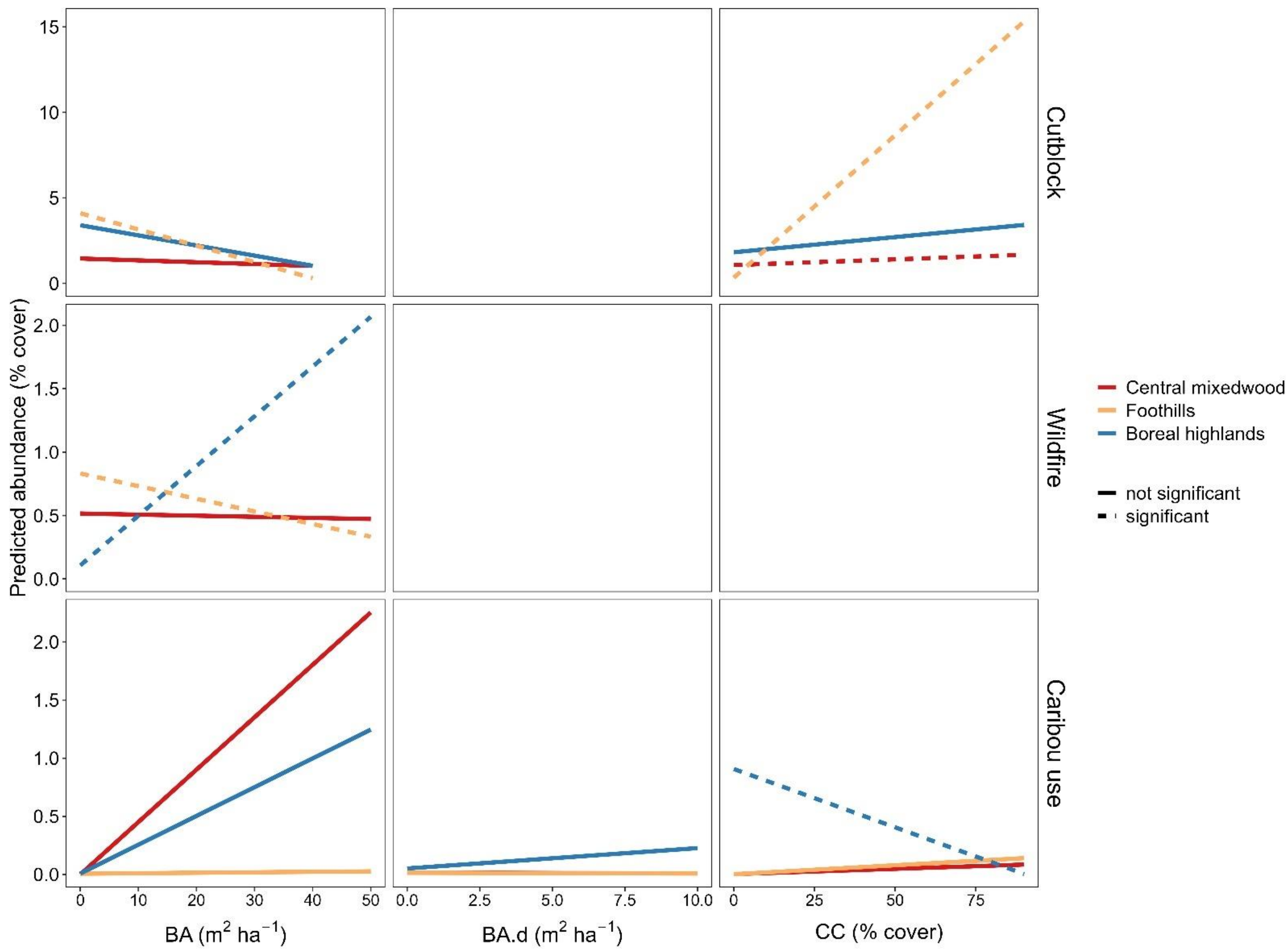

*Figure 3.16. Predicted abundance of **bear shrubs** (% cover) based on interactions between NSR (natural subregion) and covariates: basal area (BA), deciduous basal area (BA.d), and canopy cover (CC). Mapping of figure panels corresponds to mapping of interactions in Figure 2; blank panels represent intera ction not included in final model (Figure 2). Red lines represent Central Mixedwood, orange for Foothills, and dark blue for boreal highlands. Solid lines indicate non-significant effects, dashed lines indicate significant effects.*

3.4. Discussion

3.4.1. Comparison of stand characteristics among sites

Stand basal area, QMD, and canopy cover increased after both disturbance types, and did not deviate from expected regeneration dynamics following stand-replacing disturbances (Schneider 2002). In many of the NSRs, basal area, QMD, SPH, and canopy cover increased more rapidly in cutblocks versus wildfire sites, which could be due to replanting of commercial tree species (Alberta Sustainable Resource Development 2006, Pinno et al. 2021). Another explanation could be that there were fewer residual trees and CWD in the cutblocks. Ample free growing space in the cutblocks 0–10 years post-harvest could promote the recruitment of shade-intolerant, pioneer tree species like aspen (*Populus* spp.) and birch (*Betula* spp.) (Ilisson and Chen 2007, Bartels et al. 2016). This seems plausible as we also found that in comparison to wildfire sites there were fewer coniferous saplings and more deciduous trees in recent cutblocks. The greater abundance of coniferous saplings observed in the young (0–10 year) wildfire sites suggests that residual biological legacies, such as propagules, facilitated regeneration of conifer species (Greene et al. 1999, Franklin et al. 2002).

The greater depth of soil observed in wildfire sites compared to cutblocks could be due to post-wildfire legacies. Moreover, the qualitative differences observed between cutblock and wildfire sites could also be due to pre-disturbance conditions, since meaningful soil genesis would not occur over the timespan of 40 years (Rajakaruna and Boyd 2008, Estrada-Villegas et al. 2020).

CWD abundance was greatest in the early post-wildfire sites. This finding was consistent across NSRs and is in accordance with other studies (Tinker and Knight 2000, McRae et al. 2001, Yan et al. 2007, Moore 2022). We also observed high initial inputs of standing dead trees and downed debris and then a decrease in CWD over time in the wildfire sites, which resembled the initial stages of the “u-pattern” for abundance of CWD abundance following wildfire (Feller 2003, Yan et al. 2007). Infrequent CWD in cutblocks was likely due to a low occurrence of standing dead trees in tandem with the removal of downed debris, possibly for site preparation and replanting (Hagan and Grove 1999, Schneider 2002, Alberta Sustainable Resource Development 2006).

The abundance of caribou lichens was low in cutblocks for up to 40 years post-harvest. In wildfire sites the abundance of caribou lichens was low for at least 10 years post-fire. Consistent with our results, a large proportion of terrestrial lichens can be destroyed following severe, large-scale disturbance events (Coxson and Marsh 2001, Ray et al. 2015, Cichowski et al. 2022), and it can take from 40 to over 70 years for lichens to regenerate (Brulisauer et al. 1996, Waterhouse et al. 2011, Russell and Johnson 2019). The availability of caribou lichens was generally greater in wildfire sites compared to cutblocks after 10 years post-disturbance in the Central Mixedwood, and Lower and Upper Boreal Highlands. In another study conducted in the Boreal Highlands of Alberta, abundance of terrestrial lichen was also greater in post-wildfire sites compared to post-timber harvest sites (Nobert et al. 2020).

We found that both moose saplings and moose shrubs were more abundant in young timber harvest and wildfire sites compared to the caribou use sites, which is consistent with previous research (Strong and Gates 2006; McKay and Finnegan 2023). We observed a decrease in the abundance of moose saplings over time, which corresponded with observed successional patterns for the plant species associated with this forage group in boreal forests (Chen and Popadiouk 2002; Bartels et al. 2016).

Bear shrubs were generally most abundant in cutblocks, and we detected differences between cutblocks of various age classes and caribou use sites across the sampled NSRs. Our results were consistent with other studies that found fruit-bearing shrubs preferred by bears were abundant in stands following timber harvest (Nielsen et al. 2004; Souliere et al. 2020; Colton et al. 2021). We found that both moose and bear shrubs were sparce or completely absent in caribou use sites (i.e., 0 bear shrubs in Upper Boreal Highlands). This can be expected considering the successional patterns of shade-intolerant shrub species (Hart and Chen 2006) and highlights the different ecological niches of these wildlife species.

We did not observe temporal trends or many differences among site type for caribou forbs, moose forbs, and bear forbs. Generally, each of these forage groups were as abundant in the different-aged disturbance sites as in the caribou use sites. It is possible that because these forage groups contained taxa of dwarf shrubs, forbs, and graminoids, which could include both shade-tolerant and -intolerant species, the different taxa may be more abundant at different successional stages with varying degrees of canopy closure (Humbert et al. 2007).

3.4.2. Relationships between stand characteristics and forage groups among sites

We found that successional dynamics differed between timber harvest and wildfire. Some of the stand characteristics that influenced abundance of caribou lichens in wildfire sites were not important in cutblock sites. For example, canopy cover was associated with caribou lichens in wildfire sites, but not in cutblock sites. Differences between disturbance type were also observed for the forb forage groups. For instance, greater counts of coniferous saplings decreased abundance of moose and bear forbs in wildfire sites but had no effect in cutblock sites. It is possible that fire-remnant tree structures in wildfire sites provided seed sources that led to regeneration of coniferous saplings, which then limited the abundance of forbs (Carleton and MacLellan 1994; Greene et al. 1999; Humbert et al. 2007). We observed greater differences in the abundance of forage when comparing the disturbance sites with caribou use sites. For example, abundance of moose shrubs, moose saplings, and bear shrubs generally decreased with increased time since disturbance in wildfire and cutblock sites, but not in caribou use sites. These three forage groups were largely comprised of pioneer plant taxa, and likely decreased with time, following post-disturbance successional patterns (Chen and Popadiouk 2002; Hart and Chen 2006; Bartels et al. 2016). Moreover, moose shrubs, moose saplings, and bear shrubs were relatively scarce in older stands (see Section 3.3.1).

Some stand attributes had similar effects on forage groups regardless of site type. For example, soil depth limited the abundance of caribou forbs, caribou lichens, and moose saplings in all site types. Deeper soils typically hold more water and nutrients, reflecting hydric, nutrient-rich edaphic conditions (Rajakaruna and Boyd 2008; Estrada-Villegas et al. 2020), which can restrict the growth of terrestrial lichens in favor of competitors like mosses (Coxson and Marsh 2001; Nobert et al. 2020; Cichowski et al. 2022). In these sites, caribou forbs may have been outcompeted by mosses and some species of woody shrubs (Coxson and Marsh 2001). Additionally, stand-replacing disturbances often degrade soil, resulting in shallower soils in recently disturbed stands (McRae et al. 2001; Bowd et al. 2019). In young cutblock and wildfire sites with abundant moose saplings (see Section 3.3.1), the depth of the organic layer of soil was likely reduced following disturbance (Greene et al. 2007; Jean et al. 2019). Canopy cover had a positive relationship with moose and bear shrubs in both cutblock and wildfire sites. This was likely a result of the early seral forest conditions (e.g. light availability, soil properties) facilitating the growth of vascular plants (Nguyen-Xuan et al. 2000; Jean et al. 2019). Moreover, the shade-intolerant moose and bear shrubs likely remained abundant following disturbance until the canopy restricted light availability beyond the physiological requirements for those plants (Humbert et al. 2007; Hart and Chen 2008).

The impacts of stand characteristics on availability of forage varied among forage groups. Caribou lichens increased with time since disturbance while moose saplings and bear shrubs decreased with time since disturbance in both cutblock and wildfire stands. Vascular plants are often more abundant in recently disturbed forest (Schrempp et al. 2019; McClelland et al. 2023), whereas terrestrial lichens are often diminished following disturbance and gradually regenerate over time (Dunford et al. 2006; Russell and Johnson 2019). In cutblocks in our study area, basal area of deciduous trees had positive relationships with abundance of moose and bear shrubs, but negative relationships with caribou lichens, moose forbs, and bear forbs. In boreal forests in Ontario, percent cover of the shrub-layer was greatest in stands dominated by deciduous overstory, whereas percent cover of non-vascular species was greatest in coniferous stands and increased with time since disturbance (Hart and Chen 2008). In our study, the establishment of moose and bear shrubs may have constrained the growth of smaller understory vegetation, such as forbs, dwarf shrubs, and graminoids (Nguyen-Xuan et al. 2000; Jean et al. 2019).

For some forage groups, we found contrasting effects of stand characteristics on forage abundance among natural subregions. For example, greater basal area increased caribou lichens in the Central Mixedwood, but the abundance of lichens was less in the Lower and Upper Boreal Highlands. Canopy cover had a positive relationship with abundance of moose saplings in the Central Mixedwood and a negative relationship in the Upper Boreal Highlands. Furthermore, bear shrubs were not observed in any of the caribou use sites sampled in the Upper Boreal Highlands. NSRs can vary in a suite of environmental characteristics, such as forest type, dominant vegetation, amount of annual precipitation, and soil conditions (Table 1.5; Natural Regions Committee 2006). Therefore, it is not surprising that overstory attributes, such as basal area and canopy cover, had differential effects on the abundance of understory vegetation, such as lichens, shrubs, and forbs.

3.4.3. Implications for management

For stand characteristics related to merchantable timber (i.e., basal area, QMD, SPH), the post-disturbance recovery rates in the cutblocks surpassed those in the wildfire sites. By 21–30 years post-harvest, stand characteristics in cutblocks were similar to or even greater than those in similarly-aged wildfire sites and older caribou use sites. From the perspective of timber production, forest growth following timber harvest was better than following wildfire. However, those timber harvest sites likely received silvicultural treatment including planting of commercial seedlings and treatments to reduce competition from brush, which would bolster timber production (Schneider 2002; Pinno et al. 2021).

Timber harvesting did not result in a greater production of all stand characteristics. For example, caribou lichens were sparse in cutblocks and generally increased more quickly after disturbance in wildfire sites. Additionally, counts of coniferous saplings and CWD were greatest in recently burned stands when compared to cutblocks and stands used by caribou. The presence of fire-remnant tree structures, downed debris, and exposure of mineral soil in young wildfire sites may have provided seed sources and fertile soil that facilitated the regeneration of pre-disturbance species, including conifers (Carleton and MacLellan 1994; Greene et al. 1999; Franklin et al. 2002). In our study area, post-harvest site preparation typically included the removal of dead woody structures (McRae et al. 2001; Schneider 2002; Alberta Sustainable Resource Development 2006). For adaptive forest management, if timber harvest is striving to emulate wildfire, then efforts could be made to retain standing dead trees and downed woody debris (Franklin et al. 2002; Lindenmayer et al. 2012).

Timber harvest and wildfire remove overstory canopy, promoting the growth of early seral vegetation, such as forbs, shrubs, and saplings (Bergqvist et al. 2018; Schrempp et al. 2019). The availability of essential forage for moose and bears was most pronounced in cutblock sites. Our results also demonstrated that even 31–40 years post-harvest, ample forage for both moose and bears was still available in cutblocks, whereas a preferred food source for caribou, terrestrial lichens, was still limited. We also found that forage for moose and bears was positively associated with early seral conditions in cutblocks (e.g., presence of deciduous trees – Section 3.3.2). Therefore, the natural regeneration of competitive, broad-leafed tree species, like aspen and birch (Ilisson and Chen 2009; Bartels et al. 2016), following timber harvest could facilitate the growth of forage favored by moose and bears, while also limiting the growth of important forage for caribou. In our study area, commercially valuable hardwood species like aspen are restocked (Pinno et al. 2021; Alberta Agriculture and Forestry 2023), which could provide forage for moose, and indirectly increase forage for bears. Timber harvest typically includes the removal of standing dead trees and downed CWD (Hagan and Grove 1999; Schneider 2002), which could also encourage the growth of large shrubs preferred by moose and bears and constrain the abundance of forage lichens for caribou. Combined, our results suggest that post-disturbance mechanisms influencing vegetation communities could attract moose and bears, thus, reinforcing apparent competition and predation risk for caribou. These responses could be even more pronounced in recent cutblocks, as both moose and bears select harvested stands with ample forage (Leblond et al. 2016; Mumma et al. 2021; McKay and Finnegan, 2023), and where forage lichens for caribou are typically scarce (Section 3.3.1). In parts of west-central Alberta that overlap with our study area, black bears were attracted to harvest blocks that were occupied by deer (McKay and Finnegan 2022). Caribou may avoid recently disturbed forest, especially timber harvested areas, to avoid predation risk and due to a lack of preferred forage. Consequently, caribou may select older stand dominated by conifers or move to high-elevation habitats that are typical of mountain caribou in this system and others (Poole et al. 2000; Williams et al. 2021).

Our results demonstrate that disturbance-wildlife habitat relationships can vary between disturbance types and among ecosystem subtypes with differential effects that could influence broader community dynamics (e.g., competition, predation).

4. Assessment of cutblock and wildfire sites for their ability to produce future woodland caribou habitat

4.1. Background

The composition, structure, and function of boreal forest ecosystems are influenced by disturbance (Weber and Flannigan 1997; Dale et al. 2001; Gauthier et al. 2015). Across Canadian forests, wildfire has been the dominant natural disturbance and timber harvesting is the leading anthropogenic disturbance (Weber & Flannigan 1997; Masek et al. 2011; Venier et al. 2014). Timber harvest and wildfire can affect ecosystem services that are provided by forests, and the impact on ecosystem services will depend on the type, size, and severity of the disturbance (McRae et al. 2001; Thom and Seidl 2016).

Boreal forests in Canada provide a suite of ecosystem services, including the provisioning of timber products and habitat for wildlife (Burton et al. 2006; Saarikoski et al. 2015). For some wildlife species, disturbance results in habitat loss, fragmentation, or degradation, while for other species disturbance may have positive impacts, including increased food supply (Fisher and Wilkinson 2005; Ripple et al. 2015; Souliere et al. 2020). More specifically, preferred winter forage of caribou, like terrestrial lichens, is often less abundant in recently disturbed forest (Russell and Johnson 2019; Best et al. 2024). Conversely, vascular plants, like shrubs and forbs, favored by ungulates like moose, as well as omnivores like bears, are typically more abundant in early seral forest (Coxson and Marsh 2001; McClelland et al. 2023; Johnson and Rea 2024).

Timber harvest and wildfire profoundly change plant communities of boreal and montane forests (Bergeron et al. 1999; Burton 2013). However, the recovery trajectories of understory vegetation and stand characteristics can vary between the two disturbance types (McRae et al., 2001; Bergeron et al., 2004; Bartels et al., 2016). Establishment and regeneration of tree species may differ following timber harvest and wildfire, which will directly affect the growth and abundance of understory vegetation, which includes forage for wildlife (Greene et al. 1999; Ilisson and Chen 2009; Best et al. 2024). In areas prone to disturbance, effective management will need information that considers the complexity of the landscape and forest dynamics following both timber harvest and wildfire (Seidl et al. 2011; Whitman et al. 2017).

In the absence of repeated field sampling spanning decades, forest development models are useful tools that can predict stand dynamics following disturbance events (Seidl et al. 2011). Forest models generate projections of stand structure and composition over time with a focus on tree attributes (Bugmann and Seidl 2022). These models also consider stand-level conditions, such as site productivity (Bokalo et al. 2013; Bugmann and Seidl 2022). When considering the provision of wildlife habitat over time, dynamic forest models can be used to project future stand development and be used to infer how important components of wildlife habitat, such as forage will change (Bugmann et al. 2017; Lafond et al. 2017). This framework allows for the impact of timber harvest and wildfire on wildlife habitat to be projected into the future (Bugmann et al. 2017; Cristal et al. 2019).

We used forest development models to generate future projections of multiple stand characteristics in sites that had been harvested for timber or burned in wildfires (see Figures 1.2–1.4 for site locations). We linked our statistical forage models (described in Section 3.3.2) to the output of the forest models to project future provisioning of forage for caribou, moose, and bears in cutblock and wildfire sites. We compared model projections for cutblock and wildfire sites to empirical data collected at caribou use sites. That comparison allowed us to assess the temporal trajectory of forage for caribou, moose, and bears relative to undisturbed forest types typically used by boreal and mountain caribou.

4.2. Methods

4.2.1. Mixedwood Growth Models

We used mixedwood growth models (MGM) to simulate stand development for cutblock and wildfire sites (MGM21, MGM Development Team 2021). MGM is an individual tree-based growth model designed for boreal forests of western Canada (Bokalo et al. 2013). The model is distance-independent and can simulate stand development under various management practices (Bokalo et al. 2013; Johnson et al. 2022).

We initialized the model with tree and sapling data collected from 250 cutblock and 259 wildfire sites during the field surveys (Figure 4.1; described in section 1.3.2). We input DBH, height, and species for all live trees greater than 5-cm DBH. In MGM, saplings are defined as DBH < 4.0 cm and height < 1.3 m (MGM Development Team 2021). Sapling densities were available from the empirical field survey data, but specific DBH and heights were not recorded in the field. Saplings in MGM were initialized by using the measured field densities, and a random number generator was used to assign each tree's DBH (range = 2.0-3.9). We used species-specific formulas described in Huang et al. (2016) to calculate height based on DBH values for saplings. To adhere to the specifications for saplings in MGM, we limited the maximum count of saplings to 100 per species per site. For each simulated plot, we provided MGM with stand age (i.e., time since disturbance), measurement year, region (i.e., Alberta), subregion (i.e., NSR), climate moisture index (CMI), and the site index values for the simulated species (white spruce, black spruce, pine (jack or lodgepole), and trembling aspen). We derived CMI values for sites using the Alberta provincial CMI raster layer (Climate NA v. 6.11; MGM Development Team 2021). Site index values were estimated using guides for ecosite within the province of Alberta (Bjelanovic and Comeau 2019; Comeau 2020).

We used the batch function of MGM (MGM Batch Maco v1_6; MGM Development Team 2021) to project future tree growth and survival for cutblock and wildfire sites. The start year of each simulation was set to the year the site was sampled (i.e., 2021 or 2022). All stands were projected 100-years into the future with output of stand structure for each plot at a 10-year interval. We included an establish event at the start year, followed by growth and record events every 10 years. Therefore, we projected tree growth and survival to the years 2121 or 2122 with a stand age range 102–139 years. Because we provided empirical sapling data to initialize the model, we did not include additional regeneration events. Site index influences growth potential within a stand (Bokalo et al. 2013). To account for uncertainty in estimated site index we simulated each plot with three different site index values. We defined *intermediate* site index levels as those estimated using ecosite guides (Bjelanovic and Comeau 2019; Comeau 2020), *low* site index levels = intermediate – 2, and *high* site index levels = intermediate + 2.

The MGM output included stand-level summaries and full tree lists for each site. We processed the output data provided by MGM to fit the requirements of the forage models (Figure 4.1; described in Section 3.2.2.2). For basal area variables, we excluded any trees with DBH < 5 cm, which would be considered saplings based on our field data collection protocol (Section 1.3.2). We incorporated snags and stumps into basal area measurements by first determining the proportion of standing dead trees (snags + stumps) compared to all woody debris (downed CWD + snags + stumps) from our empirical data collected at all sites. Next, we multiplied MGM stand basal area values of dead trees by the proportion of standing dead trees to all woody debris (proportion = 0.485), then added the resulting amount to the MGM stand basal area values. To estimate counts of downed CWD, we first took the density values of dead trees provided by MGM and divided by 100 to represent counts at the plot-level (100-m^2 plot). Next, we multiplied the count values by the proportion of downed CWD compared to all woody debris (proportion = 0.515). To estimate counts of coniferous saplings, we calculated the sum of coniferous trees with DBH < 5 cm from the tree lists provided by MGM. Because MGM output for the initialization year (i.e., 2021 or 2022) did not include any dead trees, we replaced these values with our empirical data for basal area, deciduous basal area, and downed CWD.

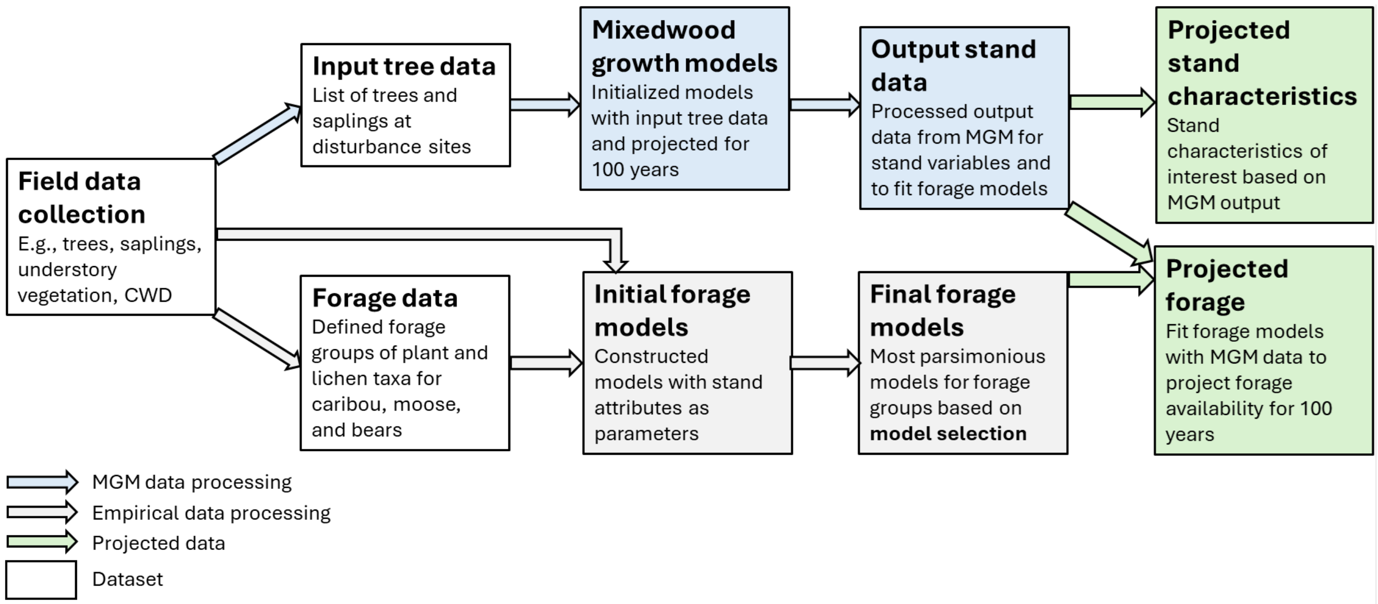

Figure 4.1. Schematic of the preparation of data for mixedwood growth models (MGM) and forage models.

4.2.2. Forage models and data analysis

We used the statistical forage models and forest projections from MGM to project forage availability in cutblock and wildfire sites over 100 years at 10-year intervals (Figure 3.17, Table A28). We constrained time since disturbance to a maximum limit of 60 years. The 60-year timeframe reflected the approximate time for forage lichens and caribou habitat to recover following wildfire (Joly et al. 2003; Rudolph et al. 2019; Russell and Johnson 2019). Additionally, we set a maximum limit of 50 for counts of downed CWD to better reflect the state space of the empirical data. For soil depth, we used the empirical values measured during field collection. The formation of new soil is a relatively slow process, and we would not expect the depth to change drastically over a period of 100 years (Stockmann et al. 2014). We used the ‘predict’ function in R incorporating the forage models and MGM output data to project forage values for each cutblock and wildfire site at 10-year intervals. We repeated the process for MGM datasets at each site index level (low, intermediate, high).

We compiled the projected values for forage groups from each site index level. For each forage group variable, we calculated relative effect size by using an ANOVA that included the factors disturbance type (cutblock, wildfire), NSR, site index (low, intermediate, high), projected year (0, 10, 20, … 100), and the interactions disturbance type × NSR and site index × NSR. We used the ‘eta_squared’ function (“effectsize” package, Ben-Shachar et al. 2020) based on total and partial sums of squares to calculate the effect size (partial η^2) of each parameter. All statistical analyses were performed using R v. 4.1.3 (R Core Team 2022).

4.3. Results

We found that site index did not explain much variance of the projected values for the stand characteristics or forage groups (Tables A29–A31). Therefore, the following results are based on the data generated with the intermediate site index level.

4.3.1. Stand characteristics projected over time

In all NSRs, basal area (BA.Alive) was projected to increase with time since disturbance in cutblock and wildfire sites (Figure 4.2). Basal area in cutblocks and wildfire sites reached values similar to those in caribou use sites as early as year 10, then exceeded those values with greater time since disturbance (Figure 4.2). Basal area of deciduous trees (BA.d.Alive) was projected to initially increase in cutblock and wildfire sites with time since disturbance, then stabilize or decrease with time (Figure 4.3). Deciduous basal area in cutblock and wildfire sites reached or exceeded values in caribou use sites by year 10. In the Foothills and Upper Boreal Highlands, deciduous basal area reached greater projected values in wildfire sites compared to those in cutblock and caribou use sites. Quadratic mean diameter was projected to increase over time in cutblocks and wildfire sites in all NSRs and exceeded values in caribou use sites in as few as 10 projected years (Figure 4.4). Both basal area and QMD were projected to be greater in cutblocks compared to wildfire sites in Central Mixedwood and Lower Boreal Highlands. Projected time explained the most variance of the projected data for QMD (Table A29). In all NSRs, stems per hectare was projected to initially increase followed by a gradual decrease over time in cutblock and wildfire sites (Figure 4.5). In cutblock and wildfire sites, SPH reached similar values as in caribou use sites from year 30–40 (Figure 4.5). Based on the effect sizes from an ANOVA, projected time explained the most variance of the projected data for basal area, QMD, and SPH (Table A29). The interaction between disturbance type and NSR explained the most variance of the projected data for deciduous basal area (Table A29).

In cutblock and wildfire sites in all NSRs, canopy cover was projected to increase with greater time since disturbance and reach values exceeding those in the caribou use sites (Figure 4.6). In cutblocks in all NSRs, canopy cover was greater than values in caribou use sites at the initialization year. Conversely, in wildfire sites, canopy cover exceeded values in caribou use sites by year 10. Counts of coniferous saplings were projected to decrease over time in both cutblock and wildfire sites in all NSRs and to reach counts less than those in caribou use sites around year 30 (Figure 4.7). In all NSRs, downed CWD was projected to initially increase, then decrease in cutblock and wildfire sites with greater time since disturbance (Figure 4.8). Counts of downed CWD in cutblock and wildfire sites were projected to reach similar counts in caribou use sites (Figure 4.8). Projected time explained the most variance of the projected data for canopy cover, coniferous saplings, and downed CWD (Table A29).

When we discretized cutblock and wildfire sites by initial stems per hectare, we found that projected values for basal area (BA.Alive) followed similar trends over time (Figure 4.9). However, the category with the lowest initial tree density (SPH < 1000) reached lower maximal basal area values, which were similar to those observed in caribou use sites (Figure 4.9). Additionally, at an initial SPH of 1000–2999, basal area values in cutblocks were greater than those in wildfire sites in the Lower Boreal Highlands. For deciduous basal area (BA.d.Alive), at the lowest initial SPH (< 1000), projected values were greater in wildfire sites than cutblocks in the Foothills and Upper Boreal Highlands (Figure 4.10). Conversely, at the intermediate and highest initial SPH, projected values were greater in cutblocks compared to wildfire sites in the Foothills. Moreover, at the highest initial SPH (≥ 3000), deciduous basal area reached the greatest values in cutblocks in the Central Mixedwood and Lower Boreal Highlands. At an initial SPH of 1000–2999, deciduous basal area in cutblocks reached similar values as in caribou use sites in most of the sampled sites (Figure 4.10).

4.3.1. Figures

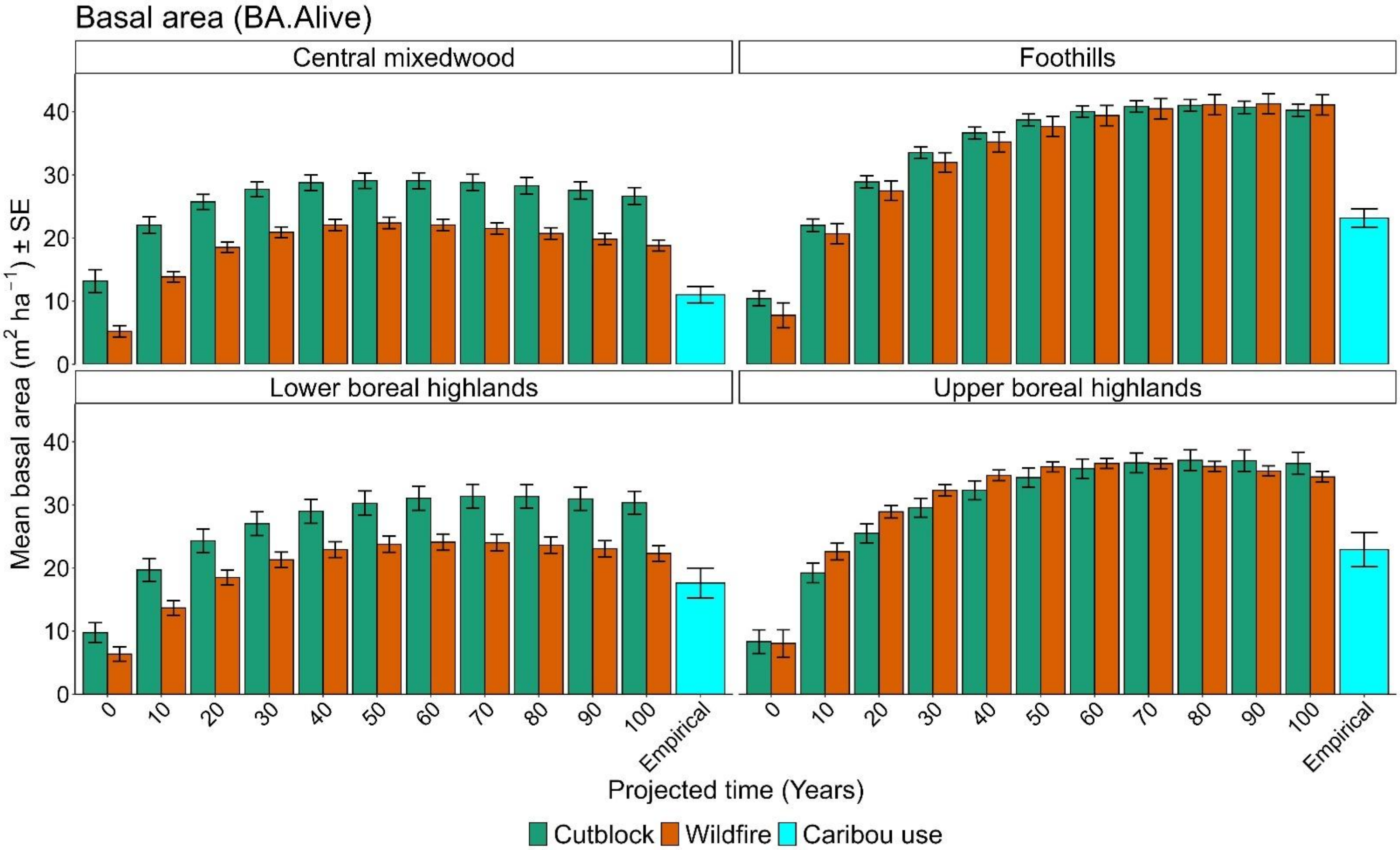

*Figure 4.2. Mean values of **basal area (BA.Alive)** projected over 100 years in cutblock and wildfire sites across natural subregions, and compared to empirical values in caribou use sites. Values of cutblock and wildfire sites generated from MGM. Values of caribou use sites based on field data collected. For projected time, 0 represents sampling year 2021 or 2022. Error bars represent standard error (SE) of the mean.*

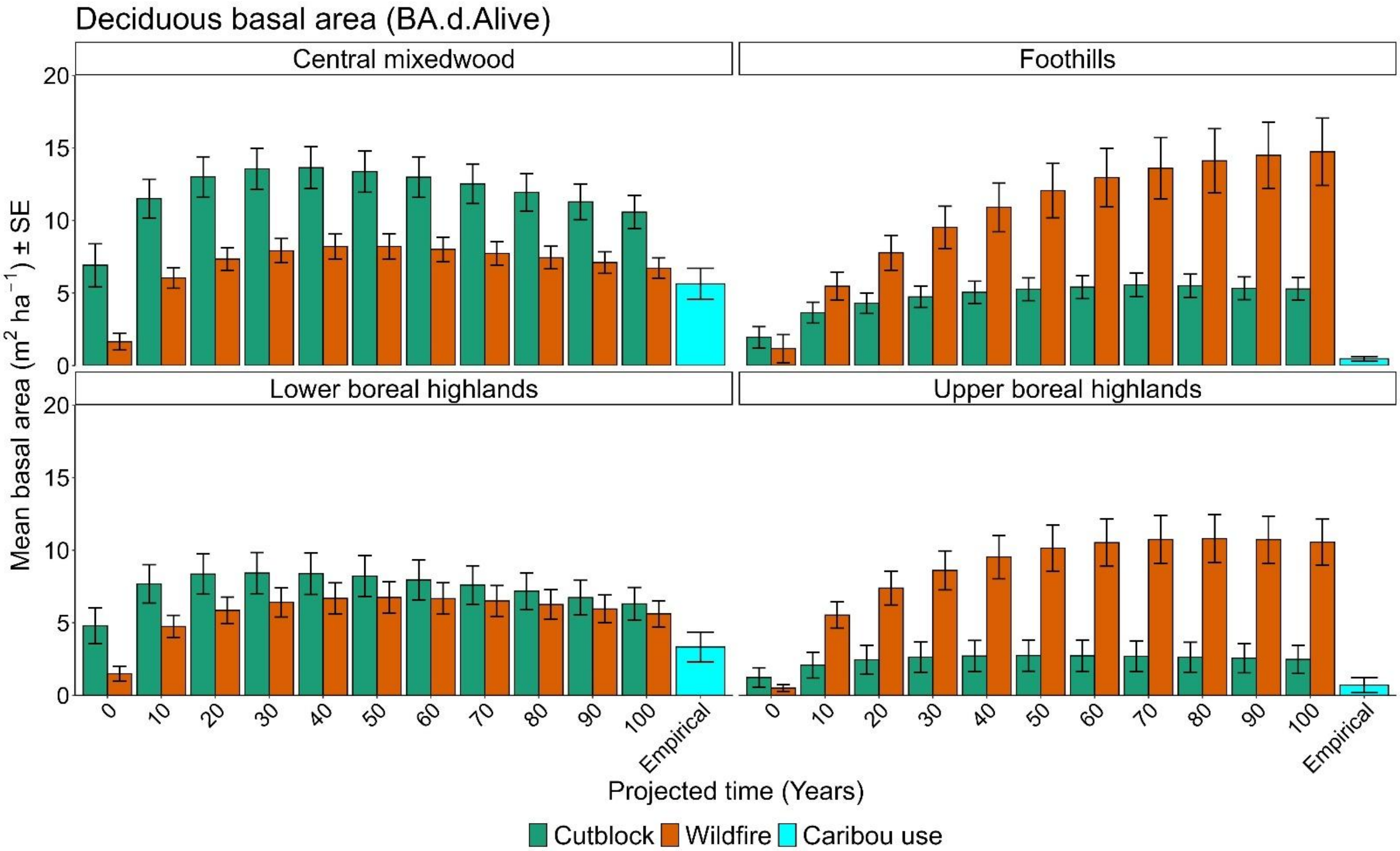

Figure 4.3. Mean values of ***deciduous basal area (BA.d.Alive)*** *projected over 100 years in cutblock and wildfire sites across natural subregions, and compared to empirical values in caribou use sites. Values of cutblock and wildfire sites generated from MGM. For projected time, 0 represents sampling year 2021 or 2022. Values of caribou use sites based on field data collected. Error bars represent standard error (SE) of the mean.*

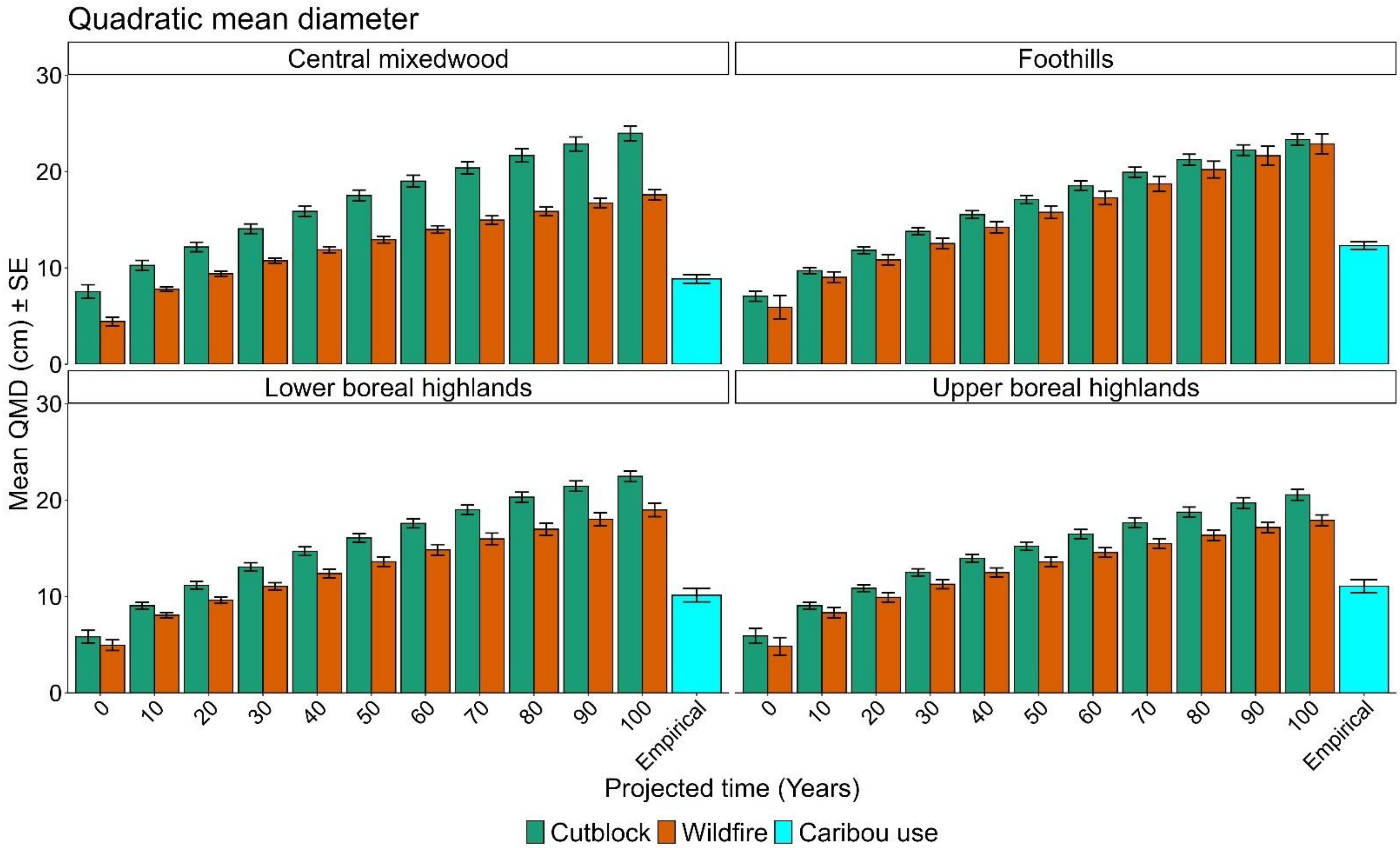

*Figure 4.4. Mean values of **quadratic mean diameter (QMD)** projected over 100 years in cutblock and wildfire sites across natural subregions, and compared to empirical values in caribou use sites. Values of cutblock and wildfire sites generated from MGM. For projected time, 0 represents sampling year 2021 or 2022. Values of caribou use sites based on field data collected. Error bars represent standard error (SE) of the mean.*

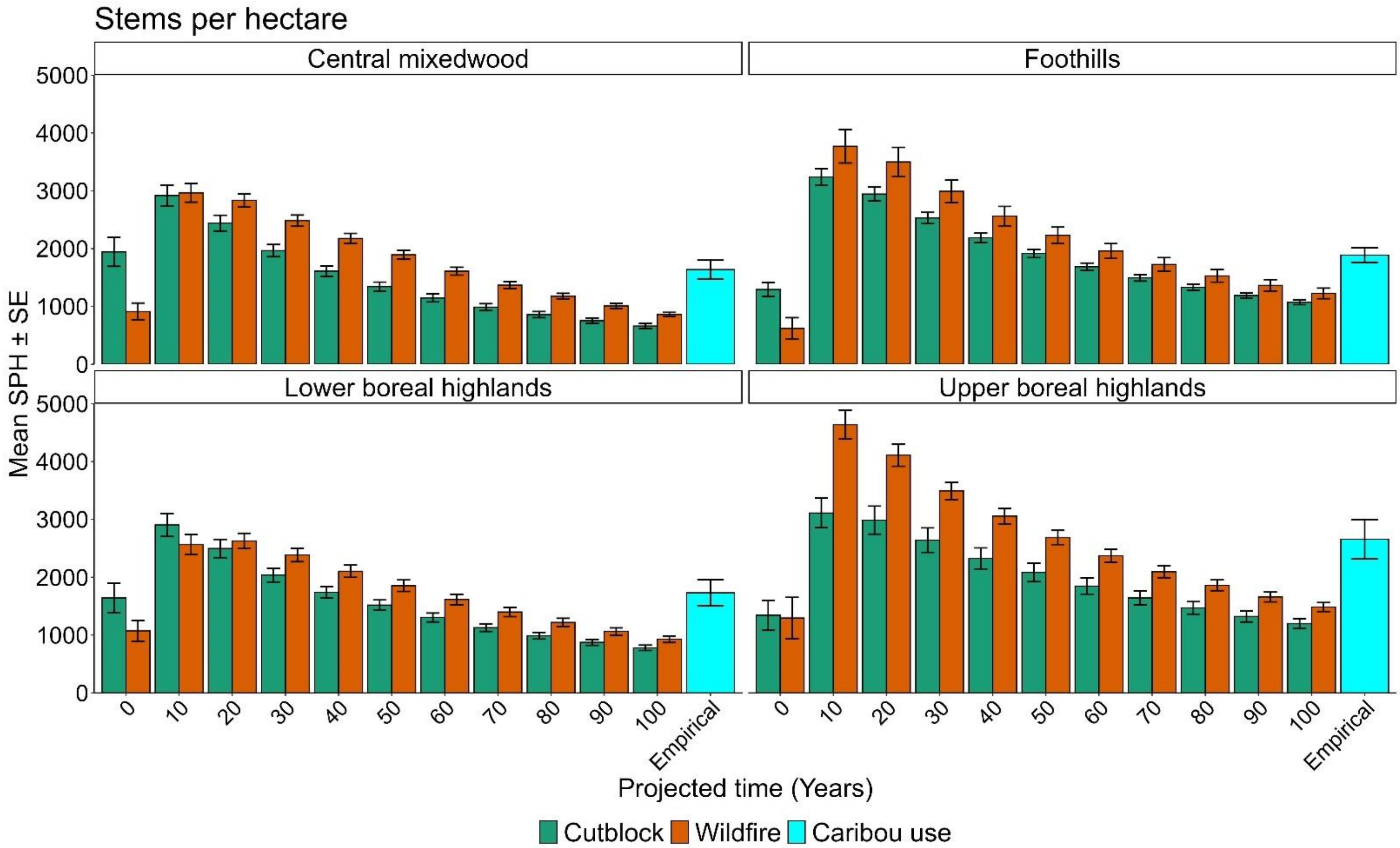

*Figure 4.5. Mean values of **stems per hectare (SPH)** projected over 100 years in cutblock and wildfire sites across natural subregions, and compared to empirical values in caribou use sites. Values of cutblock and wildfire sites generated from MGM. Values of caribou use sites based on field data collected. For projected time, 0 represents sampling year 2021 or 2022. Error bars represent standard error (SE) of the mean.*

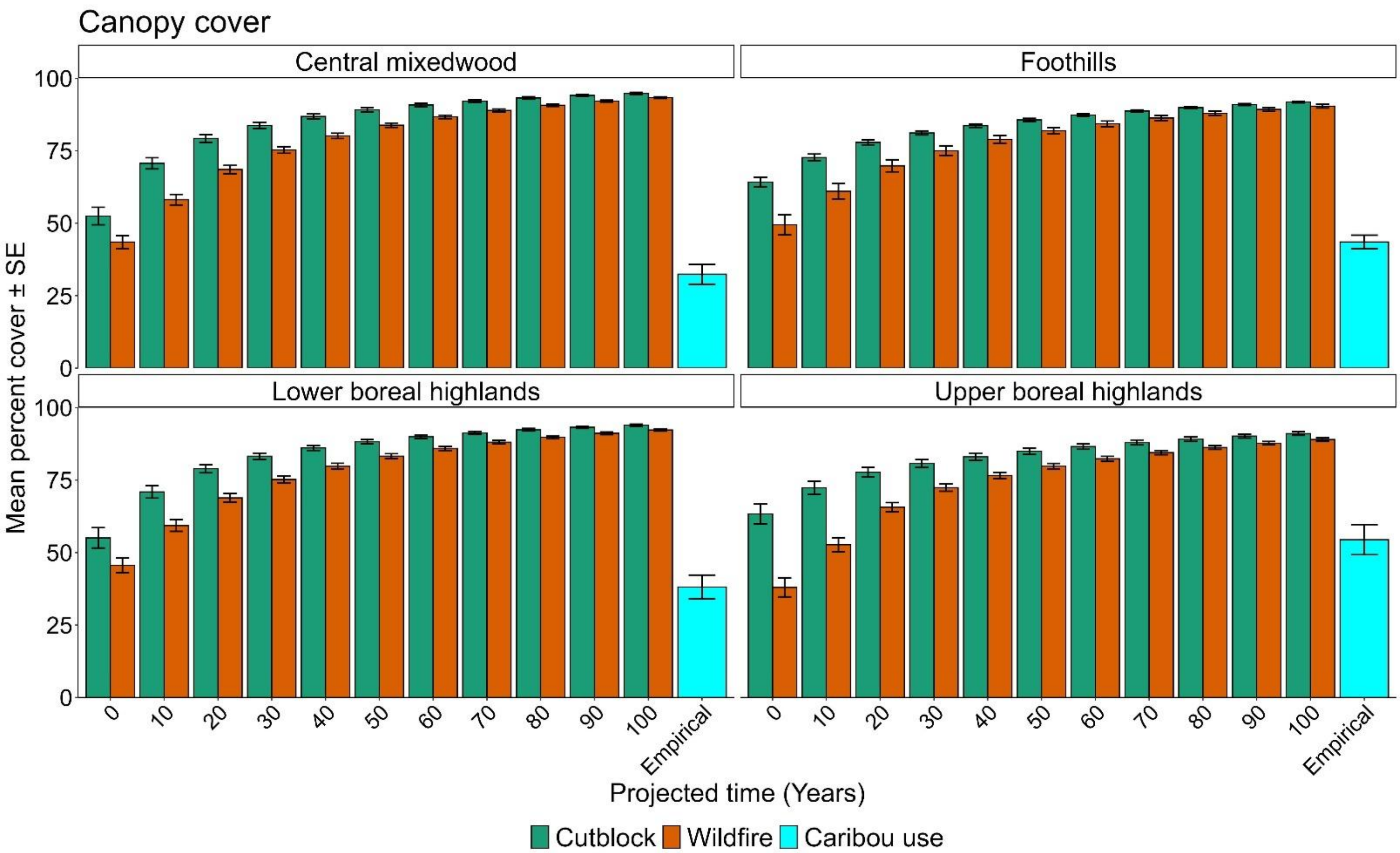

*Figure 4.6. Mean values of **canopy cover** projected over 100 years in cutblock and wildfire sites across natural subregions, and compared to empirical values in caribou use sites. Values of cutblock and wildfire sites generated from MGM. Values of caribou use sites based on field data collected. For projected time, 0 represents sampling year 2021 or 2022. Error bars represent standard error (SE) of the mean.*

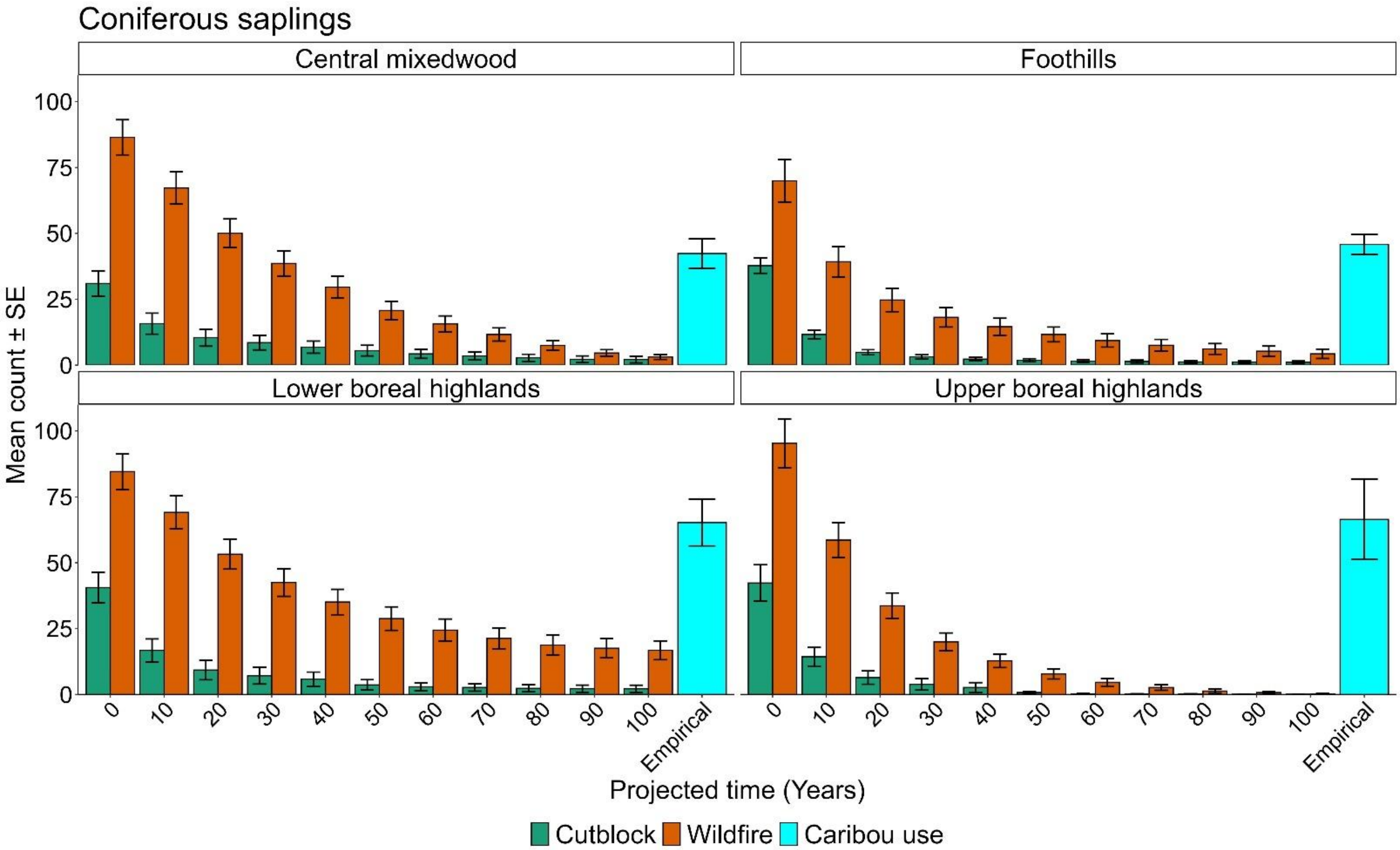

*Figure 4.7. Mean values of **coniferous saplings** projected over 100 years in cutblock and wildfire sites across natural subregions, and compared to empirical values in caribou use sites. Values of cutblock and wildfire sites generated from MGM. Values of caribou use sites based on field data collected. For projected time, 0 represents sampling year 2021 or 2022. Error bars represent standard error (SE) of the mean.*

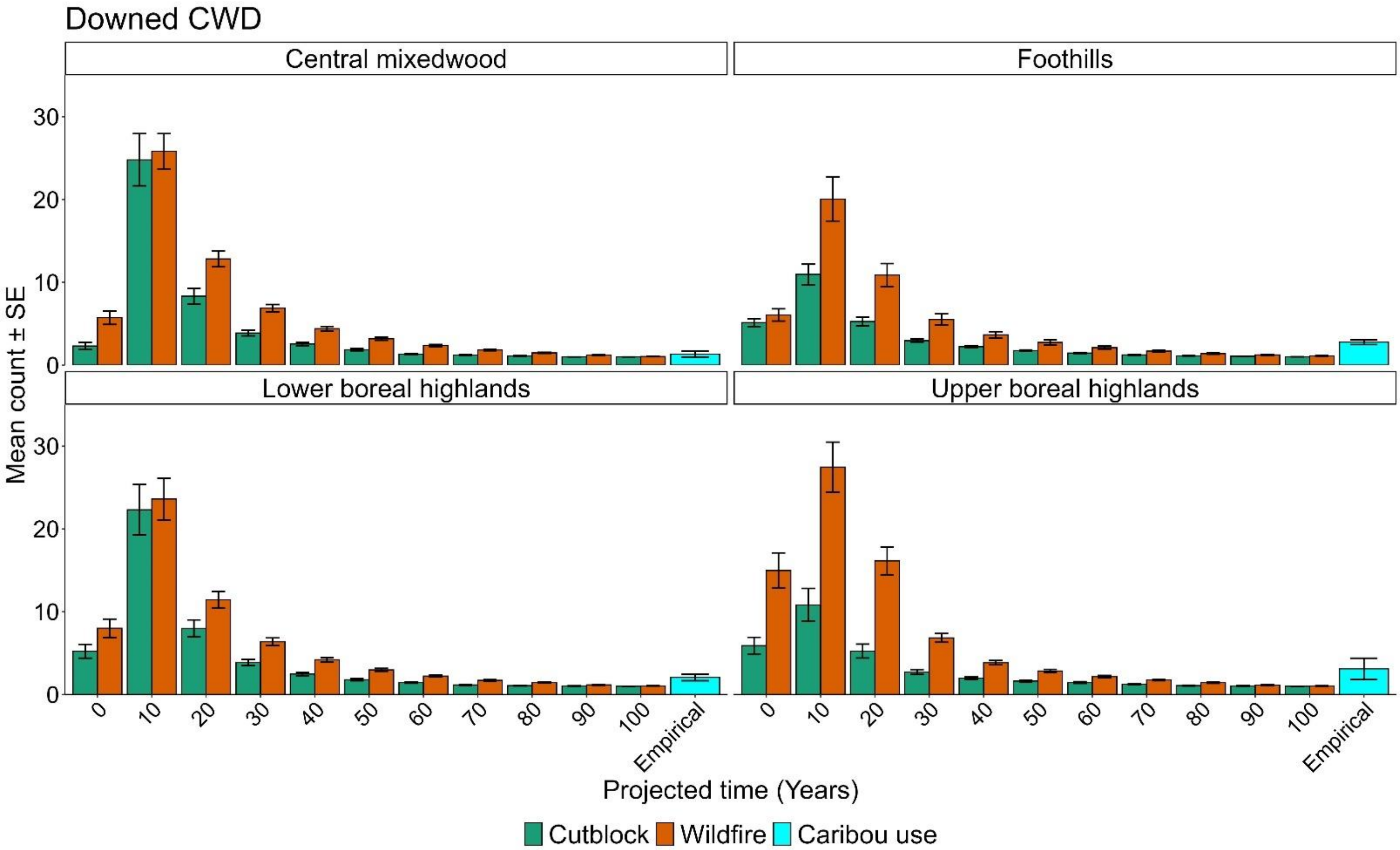

*Figure 4.8. Mean values of **downed coarse woody debris (CWD)** projected over 100 years in cutblock and wildfire sites across natural subregions, and compared to empirical values in caribou use sites. Values of cutblock and wildfire sites generated from MGM. Values of caribou use sites based on field data collected. For projected time, 0 represents sampling year 2021 or 2022. Error bars represent standard error (SE) of the mean.*

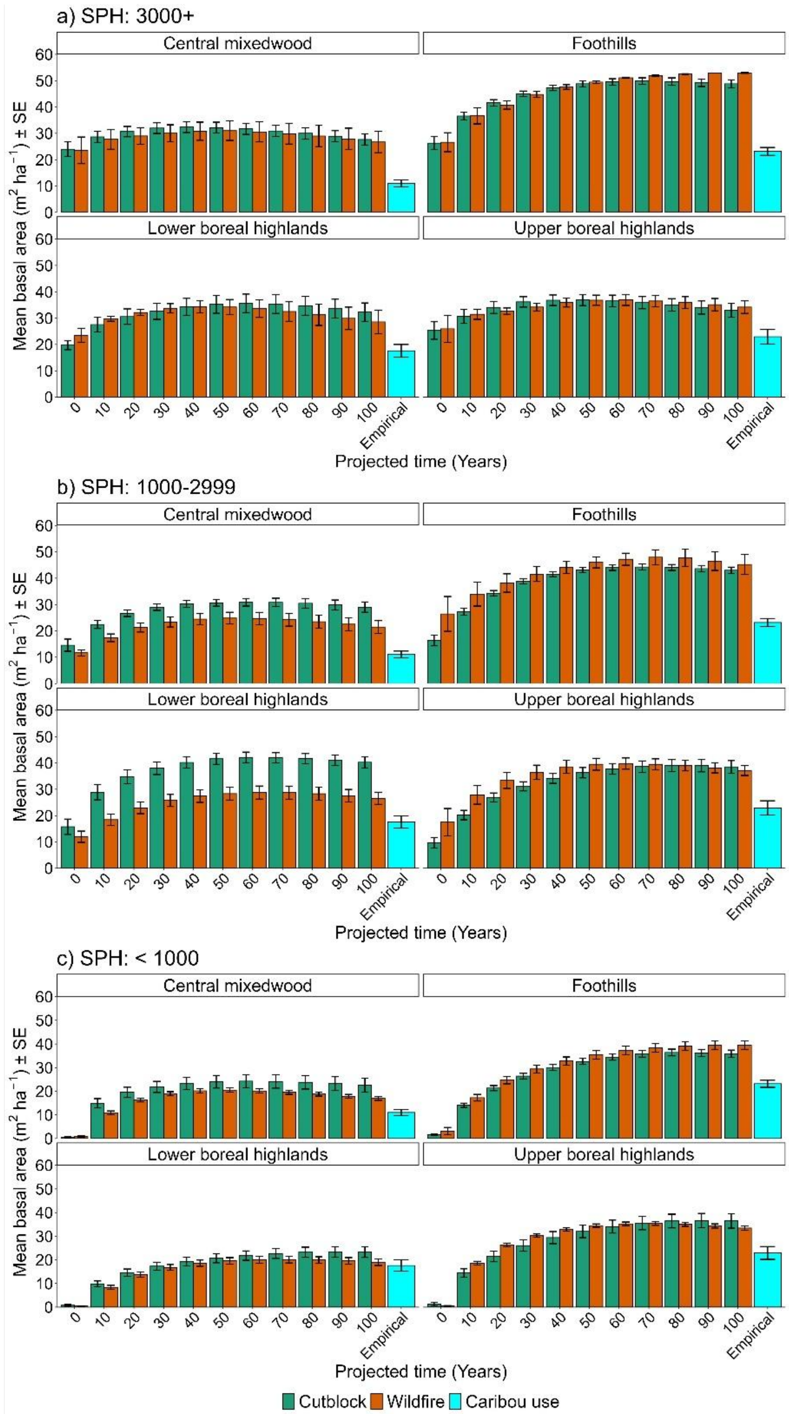

*Figure 4.9. Mean projected values of **basal area (BA.Alive)** in cutblock and wildfire sites at different initial tree densities: a) SPH ≥ 3000, b) SPH = 1000–2999, and c) SPH < 1000, compared across natural subregions. Empirical values for caribou use sites were not discretized by initial SPH. For projected time, 0 represents sampling year 2021 or 2022. Error bars represent standard error (SE) of the mean.*

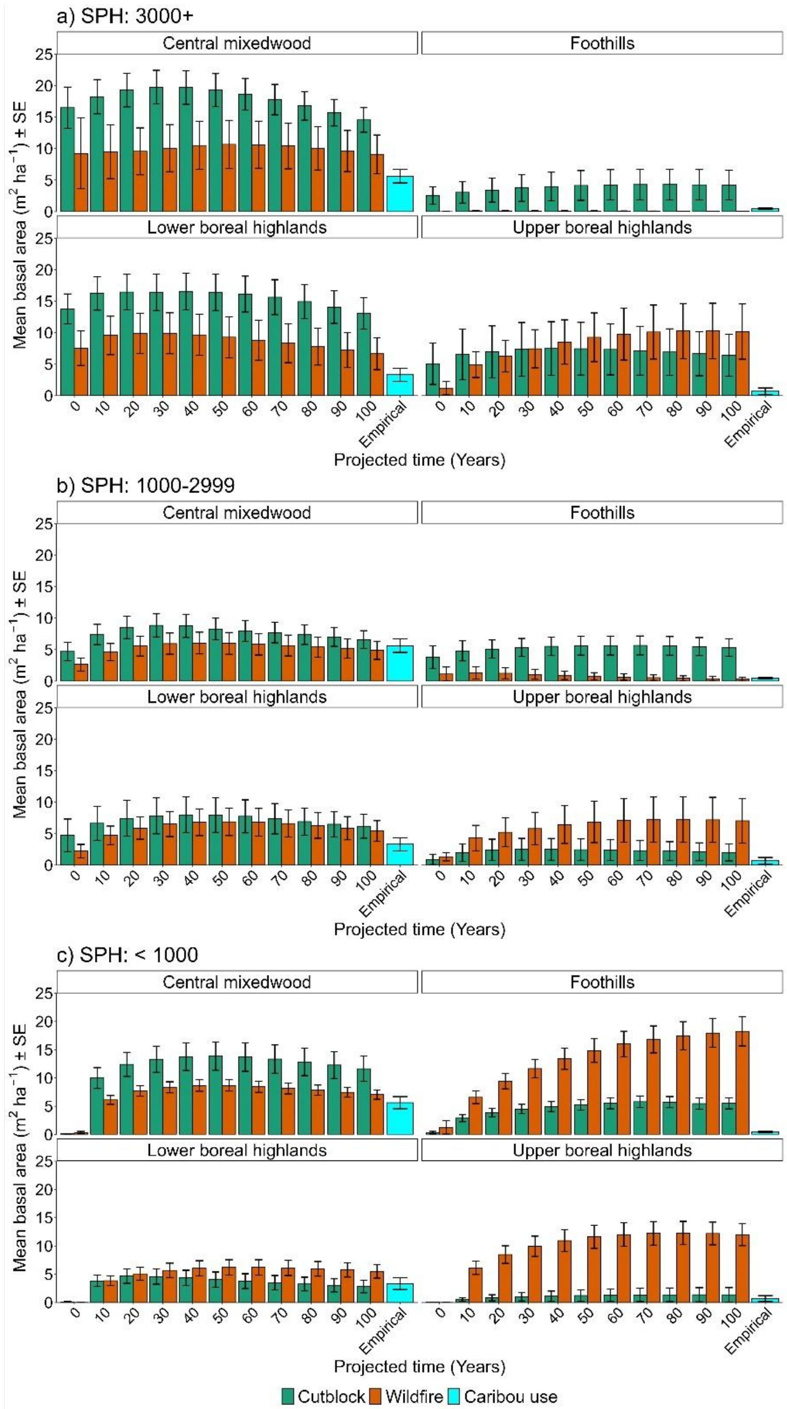

*Figure 4.10. Mean projected values of **deciduous basal area (BA.d.Alive)** in cutblock and wildfire sites at different initial tree densities: a) SPH ≥ 3000, b) SPH = 1000–2999, and c) SPH < 1000, compared across natural subregions. Empirical values for caribou use sites were not discretized by initial SPH. For projected time, 0 represents sampling year 2021 or 2022. Error bars represent standard error (SE) of the mean.*

4.3.2. Forage groups projected over time

Caribou forage

Abundance of caribou forbs was projected to decrease over time in wildfire sites in all NSRs reaching values similar to or less than those in the caribou use sites (Figure 4.11). In cutblock sites in the Central Mixedwood and Foothills, caribou forbs were projected to increase then stabilize with greater time since disturbance (Figure 4.11). In contrast, caribou forbs were projected to decrease over time in the cutblock sites in the lower and Upper Boreal Highlands (Figure 4.11). Furthermore, caribou forbs were projected to generally be more abundant in cutblock sites compared to wildfire and caribou use sites in all NSRs except for the Upper Boreal Highlands (Figure 4.11). This trend was observed around year 30. Disturbance type explained the most variance of the projected data for caribou forbs (Table A31).

Caribou lichens were projected to increase in abundance and then stabilize around year 50 in cutblock and wildfire sites in all NSRs (Figure 4.12). Caribou lichens were projected to be more abundant in cutblock sites compared to wildfire sites in all NSRs except for the Foothills where projected values were greater in wildfire sites (Figure 4.12). In cutblock and wildfire sites in the Central Mixedwood and cutblocks in the Lower Boreal Highlands, caribou lichens were projected to approach similar abundance as in the caribou use sites by year 50 (Figure 4.12). In the Upper Boreal Highlands, the projected abundance of caribou lichens in cutblock and wildfire sites was far less than in caribou use sites. NSR and projected time explained the most variance of the projected data for caribou lichens (Table A31).

Moose forage

Moose forbs were projected to decrease then stabilize around year 50 in cutblock and wildfire sites in all NSRs except for the Foothills (Figure 4.13). In wildfire sites in the Foothills, moose forbs were projected to increase with time since disturbance, reaching a greater abundance than in cutblock and caribou use sites (Figure 4.13). In cutblock and wildfire sites in the other NSRs, moose forbs were projected to approach a similar abundance as in the caribou use sites (Figure 4.13). NSR and the interaction between disturbance type and NSR explained the most variance of the projected data for moose forbs (Table A31).

In cutblock and wildfire sites in all NSRs, moose saplings were projected to decrease and then stabilize at year 40 and approach similar counts as those in caribou use sites (Figure 4.14). Projected time explained the most variance of the projected data for moose saplings (Table A31).

Moose shrubs were projected to initially decrease to year 40 when this forage type then stabilized in cutblock and wildfire sites in all NSRs except for the Upper Boreal Highlands (Figure 4.15). In wildfire sites in the Upper Boreal Highlands, moose shrubs were projected to increase over time and reach a greater abundance than in cutblock and caribou use sites. In cutblock and wildfire sites in the other NSRs, projected abundance of moose shrubs was also greater than in caribou use sites (Figure 4.15). The interaction between disturbance type and NSR explained the most variance of the projected data for moose shrubs (Table A31).

Bear forage

Bear forbs were projected to slightly decrease then stabilize over time in wildfire sites in all NSRs (Figure 4.16). In cutblock sites in the Central Mixedwood and Foothills, bear forbs were projected to increase up to year 50 then stabilize to reach a greater abundance when compared to wildfire and caribou use sites (Figure 4.16). In contrast, bear forbs were projected to initially decrease then stabilize in cutblock sites in the Lower and Upper Boreal Highlands (Figure 4.16). Disturbance type and the interaction between disturbance type and NSR explained the most variance of the projected data for bear forbs (Table A31).

In cutblock sites in all NSRs, abundance of bear shrubs was projected to decrease until around year 50 then reach a stable trend that was similar to or exceeded the abundance in wildfire and caribou use sites (Figure 4.17). Conversely, bear shrubs remained relatively stable over the 100-year projected timeframe in wildfire sites in all NSRs (Figure 4.17). Disturbance type explained the most variance of the projected data for bear shrubs (Table A31).

4.3.2. Figures

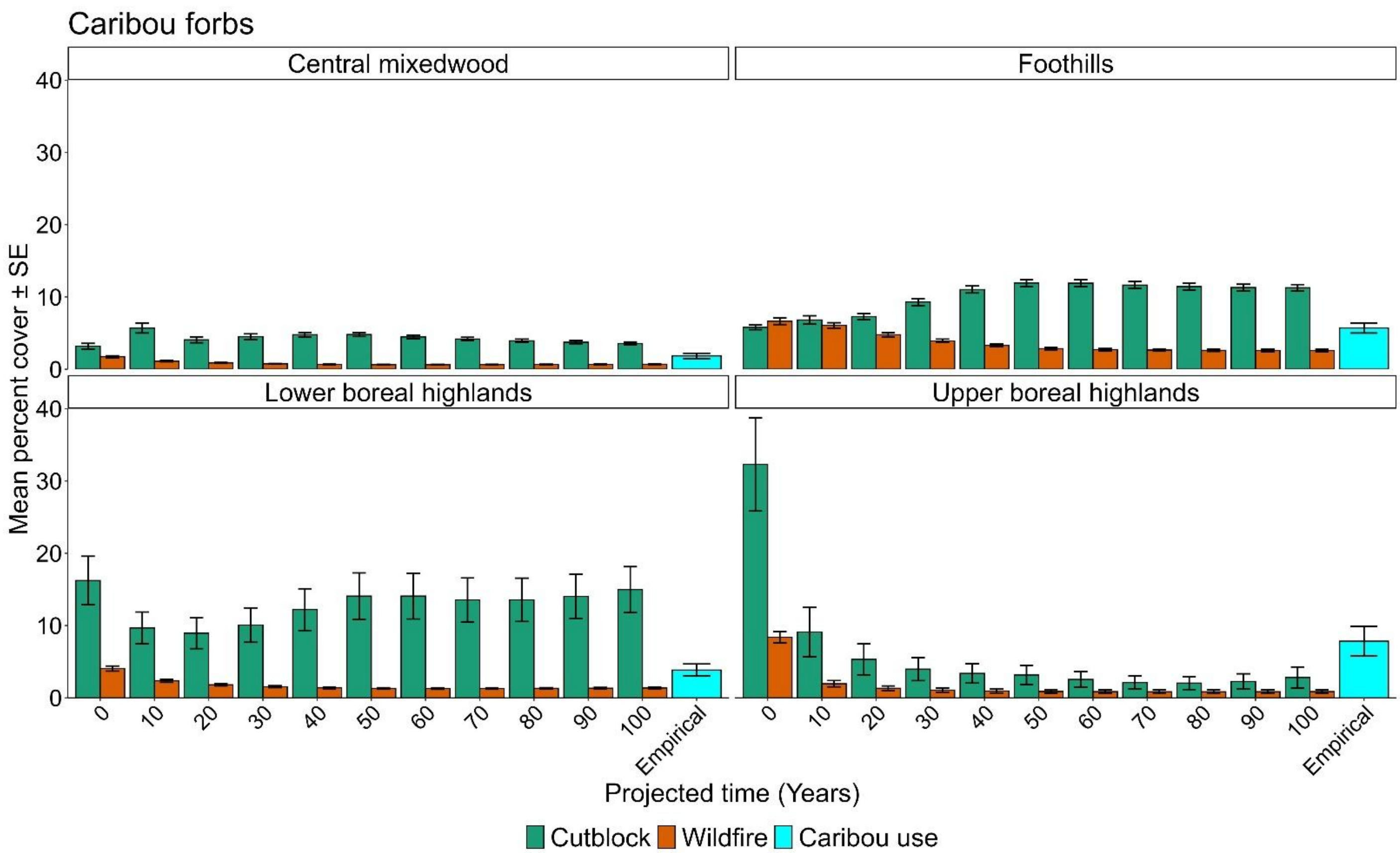

*Figure 4.11. Mean values of **caribou forbs** projected over 100 years in cutblock and wildfire sites across natural subregions, and compared to empirical values in caribou use sites. Values of cutblock and wildfire sites generated from MGM. Values of caribou use sites based on field data collected. For projected time, 0 represents sampling year 2021 or 2022. Error bars represent standard error (SE) of the mean.*

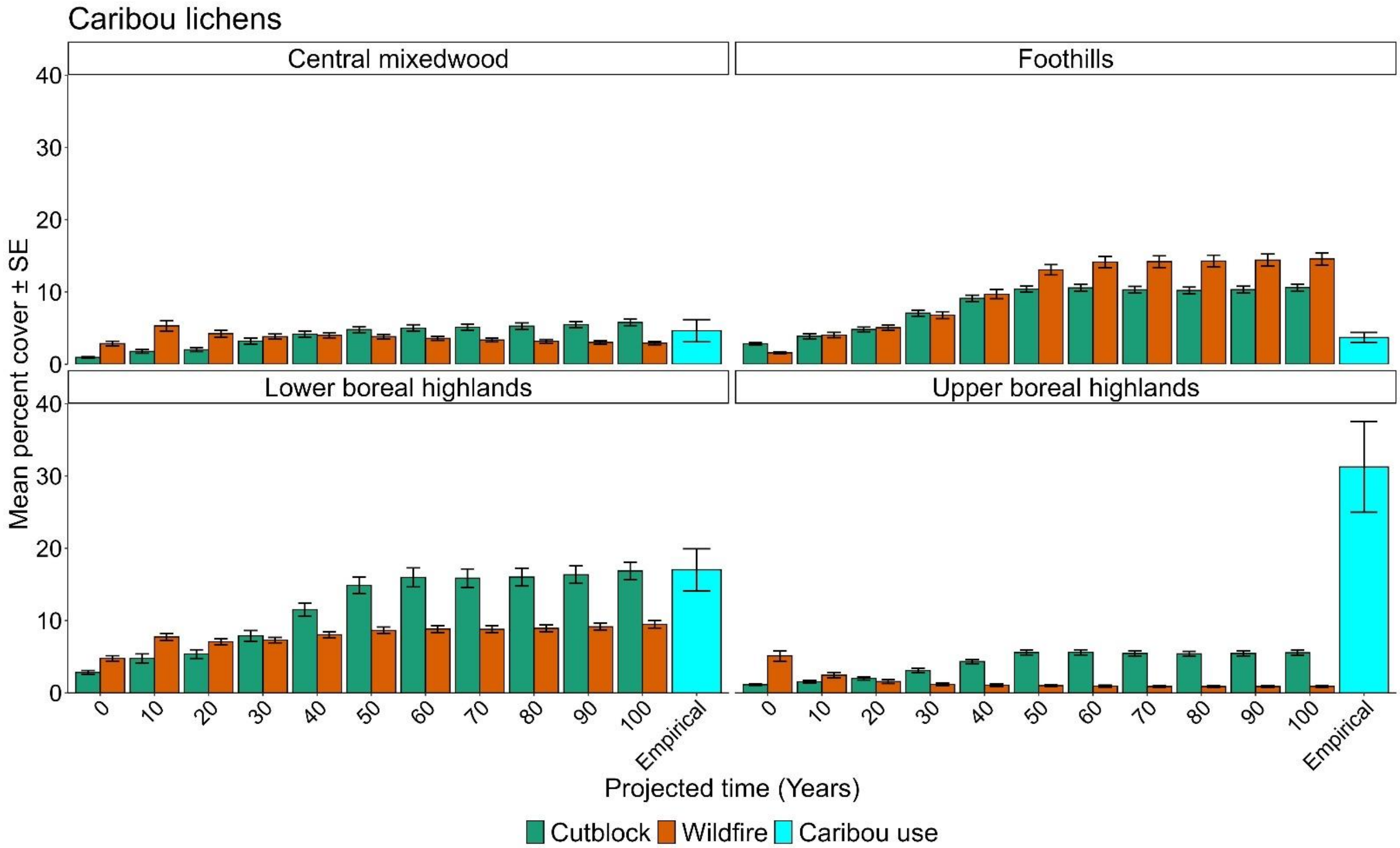

*Figure 4.12. Mean values of **caribou lichens** projected over 100 years in cutblock and wildfire sites across natural subregions, and compared to empirical values in caribou use sites. Values of cutblock and wildfire sites generated from MGM. Values of caribou use sites based on field data collected. For projected time, 0 represents sampling year 2021 or 2022. Error bars represent standard error (SE) of the mean.*

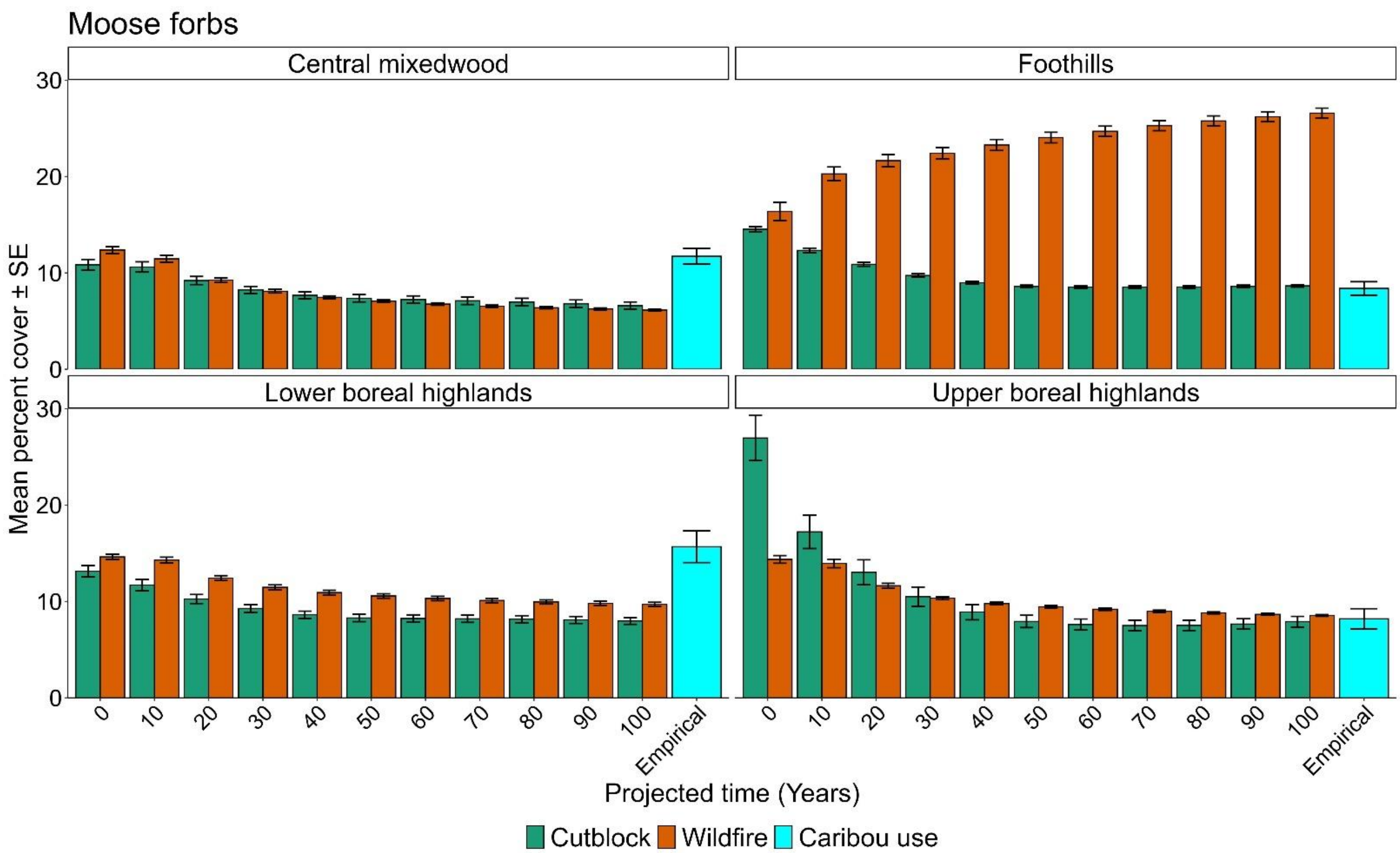

*Figure 4.13. Mean values of **moose forbs** projected over 100 years in cutblock and wildfire sites across natural subregions, and compared to empirical values in caribou use sites. Values of cutblock and wildfire sites generated from MGM. Values of caribou use sites based on field data collected. For projected time, 0 represents sampling year 2021 or 2022. Error bars represent standard error (SE) of the mean.*

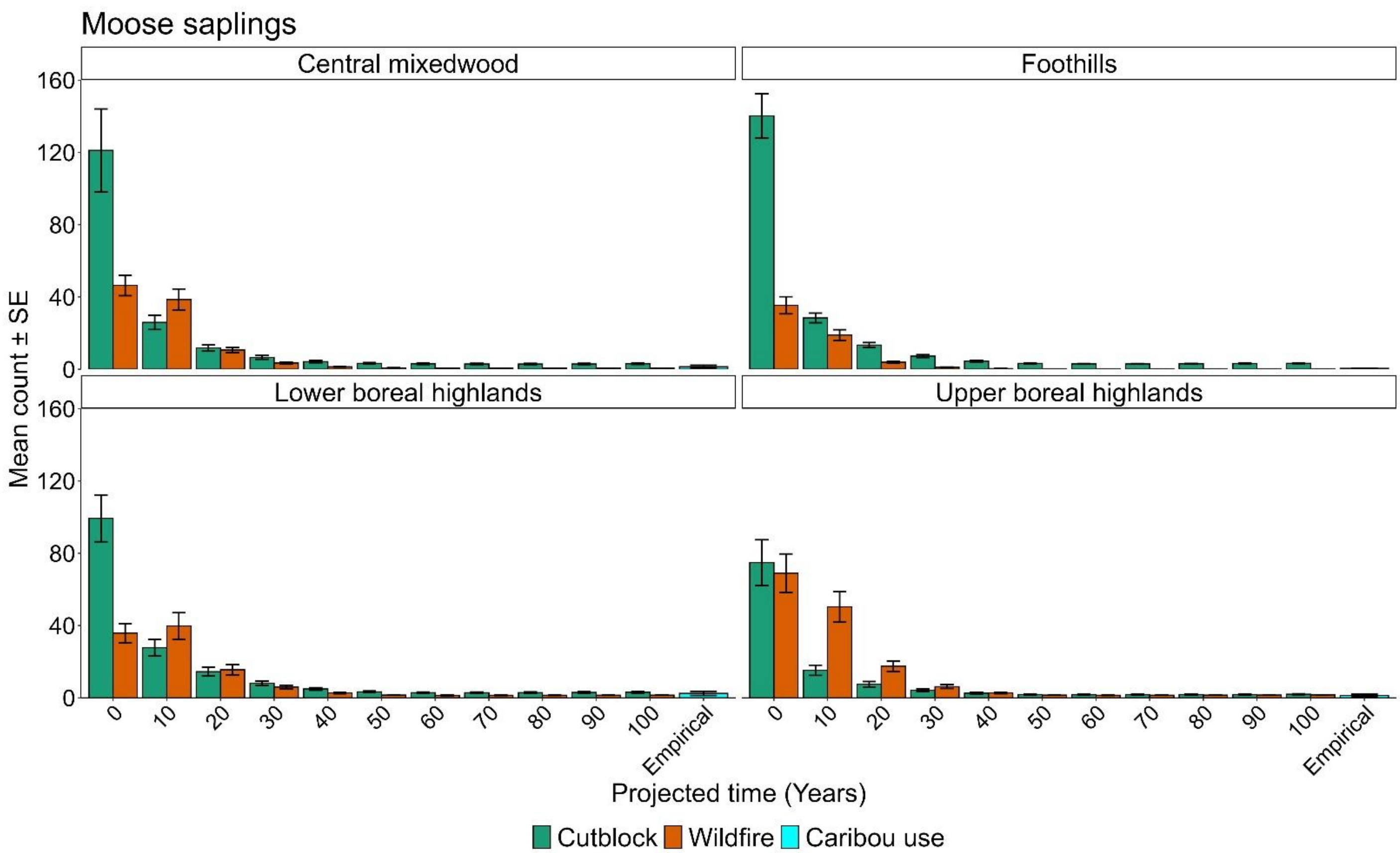

*Figure 4.14. Mean values of **moose saplings** projected over 100 years in cutblock and wildfire sites across natural subregions, and compared to empirical values in caribou use sites. Values of cutblock and wildfire sites generated from MGM. Values of caribou use sites based on field data collected. For projected time, 0 represents sampling year 2021 or 2022. Error bars represent standard error (SE) of the mean.*

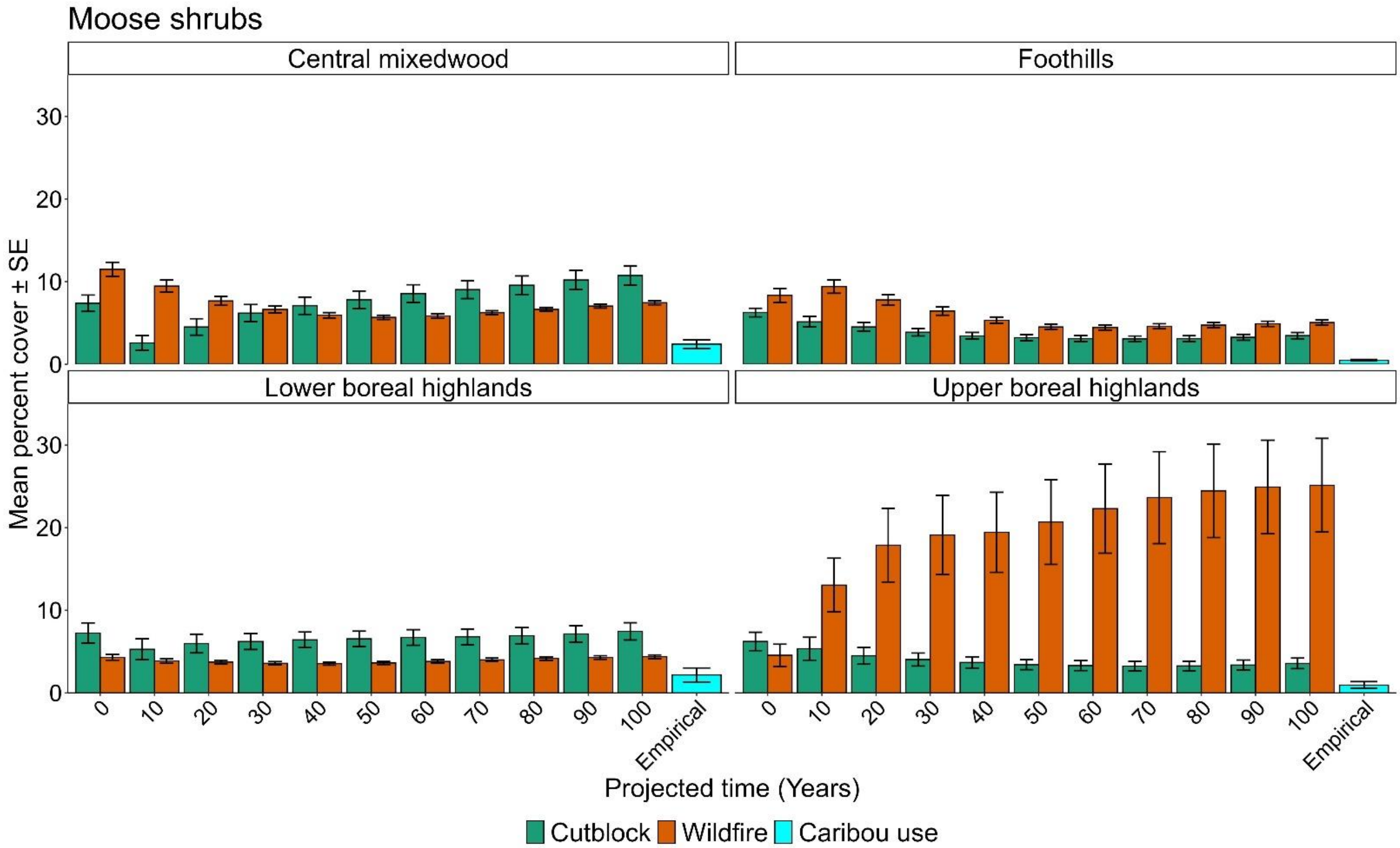

*Figure 4.15. Mean values of **moose shrubs** projected over 100 years in cutblock and wildfire sites across natural subregions, and compared to empirical values in caribou use sites. Values of cutblock and wildfire sites generated from MGM. Values of caribou use sites based on field data collected. For projected time, 0 represents sampling year 2021 or 2022. Error bars represent standard error (SE) of the mean.*

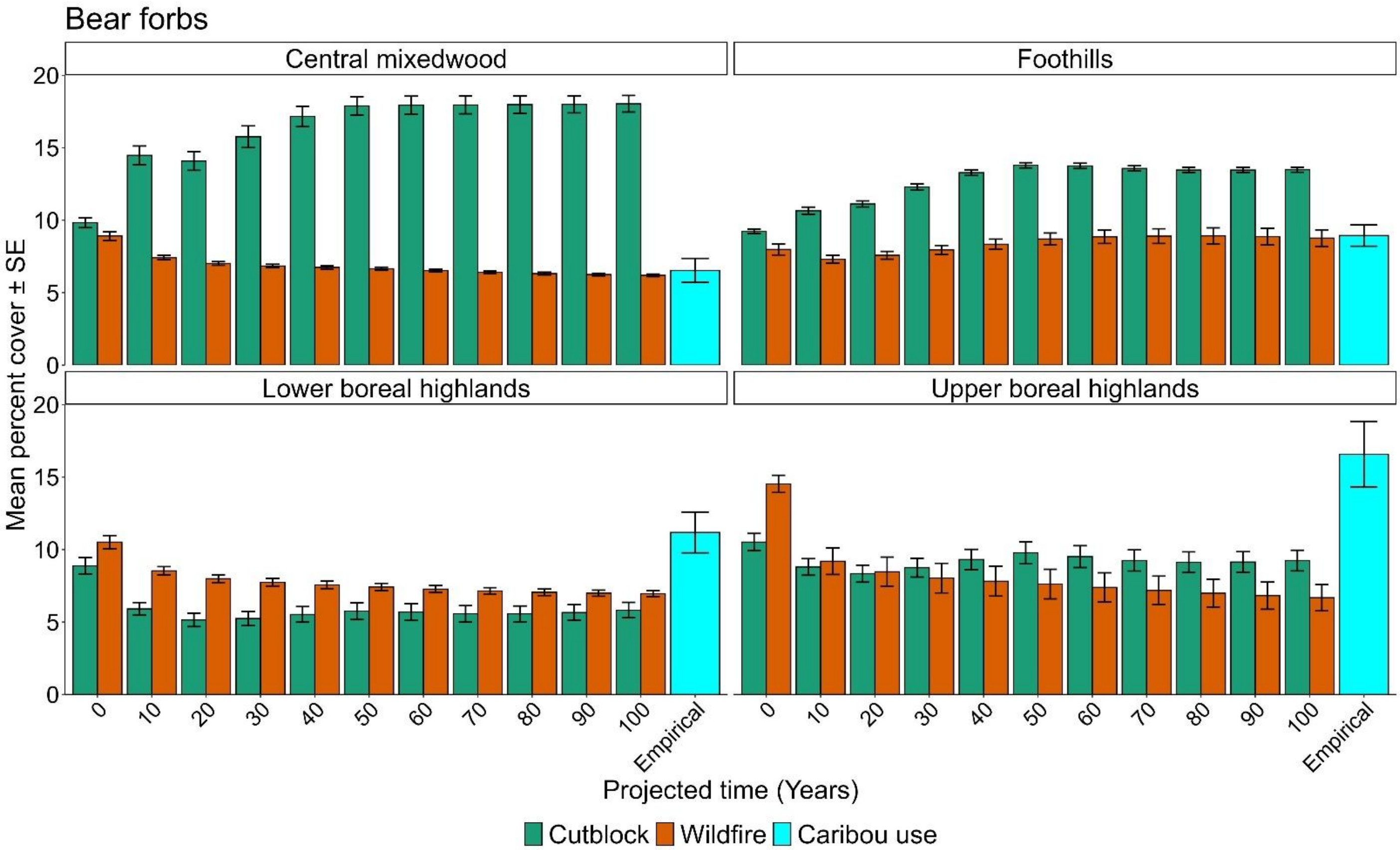

*Figure 4.16. Mean values of **bear forbs** projected over 100 years in cutblock and wildfire sites across natural subregions, and compared to empirical values in caribou use sites. Values of cutblock and wildfire sites generated from MGM. Values of caribou use sites based on field data collected. For projected time, 0 represents sampling year 2021 or 2022. Error bars represent standard error (SE) of the mean.*

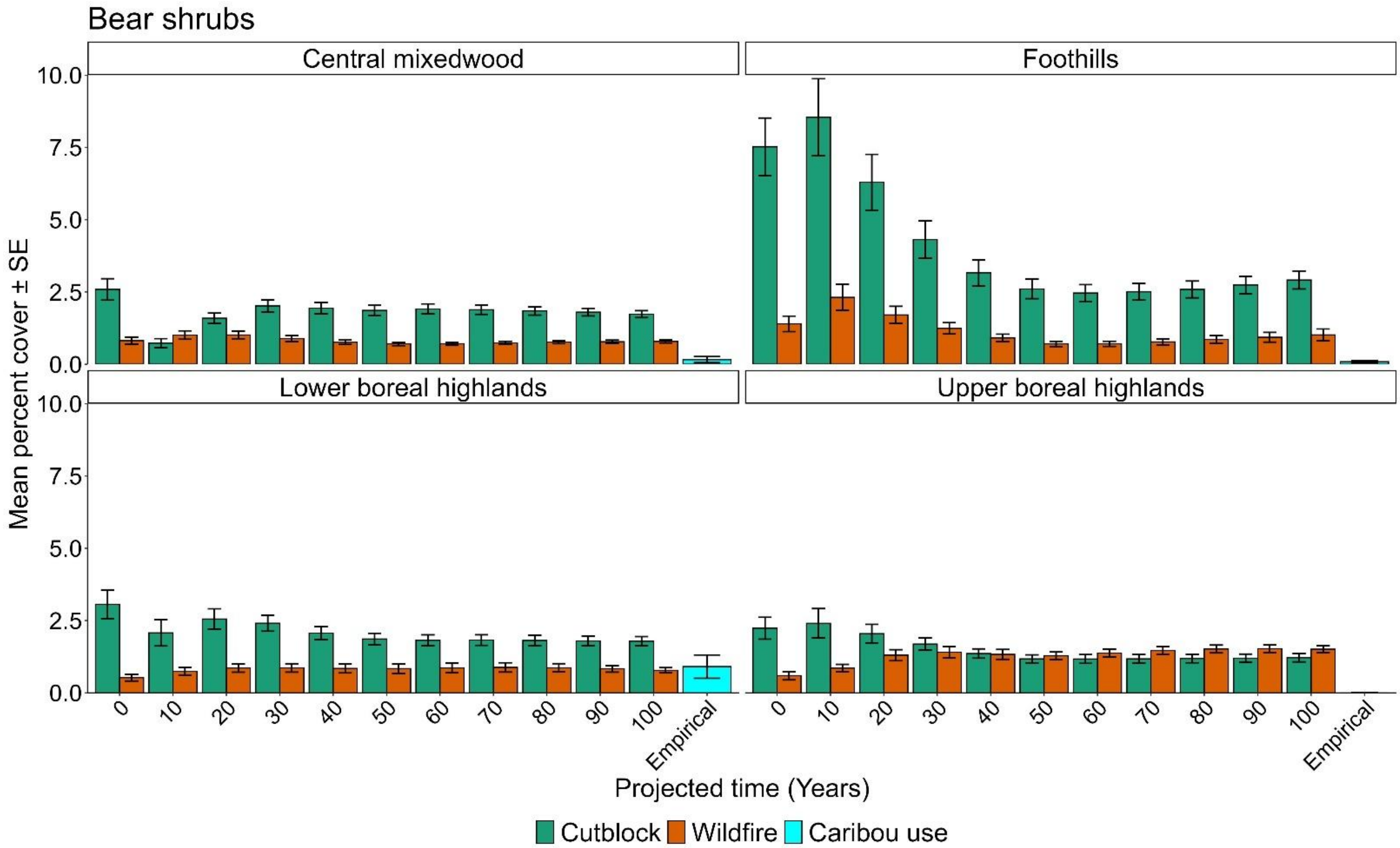

*Figure 4.17. Mean values of **bear shrubs** projected over 100 years in cutblock and wildfire sites across natural subregions, and compared to empirical values in caribou use sites. Values of cutblock and wildfire sites generated from MGM. Values of caribou use sites based on field data collected. For projected time, 0 represents sampling year 2021 or 2022. Bear shrubs were not observed in caribou use sites in the Upper Boreal Highlands. Error bars represent standard error (SE) of the mean.*

4.4. Discussion

4.4.1. Stand characteristics projected over time

We found that model projections for stand characteristics in cutblock and wildfire sites were largely consistent with expected successional dynamics for these ecosystems (Greene et al. 1999; Yan et al. 2007; Hart and Chen 2008; Bartels et al. 2016). For example, basal area (BA.Alive) increased over time and stabilized at values ranging from 30–40 m^2 ha^{-1}, while stems per hectare decreased over time to reach values ranging from 1000–2000. Based on model projections, cutblock and wildfire sites ultimately reached basal areas of closed-canopy forest (Hart and Chen 2008; Schrempp et al. 2019). In contrast, counts of downed CWD and coniferous saplings decreased with greater time since disturbance (Sturtevant et al. 1997; Yan et al. 2007).

We observed differences in stand characteristics between disturbance types among different NSRs. For instance, projections of basal area of deciduous trees (BA.d.Alive) were greater in cutblocks than in wildfire sites in the Central Mixedwood, but greater in wildfire sites than in cutblocks in the Foothills and Upper Boreal Highlands. This may be explained by differential impacts of each disturbance type (McRae et al. 2001), coupled with variation in environmental characteristics among the NSRs (Table 1.5, Natural Regions Committee 2006). Projected counts of coniferous saplings were initially greater in wildfire sites compared to cutblocks in all NSRs. As described in Section 3.4.1, the greater number of coniferous saplings in wildfire sites may be attributed to seed sources provided by remnant, coniferous trees (Greene et al. 1999, Franklin et al. 2002).

When comparing the projections of stand characteristics in cutblock and wildfire sites to observed values in caribou use sites, values were generally most similar at early projected years. For example, basal area, deciduous basal area, and QMD reached similar values to those in caribou use sites by year 10. In cutblocks in some NSRs, stand characteristics were projected to exceed values in caribou use sites by year 10. For instance, this was found for basal area, QMD, and canopy cover in cutblock sites in the Central Mixedwood. This elevated forest growth and provisioning of timber could be due to silvicultural treatments in these sites (Schneider 2002; Pinno et al. 2021), which could be evaluated in future research.

4.4.2. Forage groups projected over time

The projected trajectory of wildlife forage greatly varied among NSRs and disturbance type. Except moose saplings, we did not observe consistent trends of projected abundance of forage among the NSRs. Additionally, we found many pronounced differences between disturbance types. For many of the forage groups, disturbance type and the interaction between NSR and disturbance type explained the most variance of the projected data. For example, moose shrubs were projected to be more abundant in cutblock sites than in wildfire sites in the Central Mixedwood and Lower Boreal Highlands, but more abundant in wildfire sites than in cutblocks in the Upper Boreal Highlands. For moose shrubs and other forage groups, the variation in trajectories between disturbance type and among NSR can likely be explained by the inclusion and significance of NSR-interactions in the forage models (described in Section 3.2.2.1, Figure 3.9, Table A28).

Model projections indicated that caribou lichens generally increased over time. This result is similar to previous empirical research that reported greater abundance or cover of terrestrial lichens in older forest types (Brulisauer et al. 1996; Waterhouse et al. 2011; Russell and Johnson 2019). Consistent with stand dynamics (Chen and Popadiouk 2002; Bartels et al. 2016), moose saplings were projected to decrease over time in cutblock and wildfire sites and reach counts similar to those in caribou use sites as early as 40 projected years. The same general trend was not observed for projections of moose shrubs and bear shrubs, which also represented pioneer plant species (see Table 2.1). An explanation for these dissimilarities could be the relative importance of time since disturbance to the respective forage models (Tables A24, A25, A27). The lack of trends for the forb forage groups may be explained by the taxa included in these forage groups, which included both shade-tolerant and -intolerant species (see Table 2.1). The relative abundance of these species may differ among successional stages (Coxson and Marsh 2001; Humbert et al. 2007; Hart and Chen 2008).

The comparison of projected values in disturbance sites to observed values in caribou use varied among NSR for the forage groups. For instance, projected abundance of caribou lichens was greater in cutblock and wildfire sites than in caribou use sites in the Foothills, but far less in disturbance sites than caribou use sites in the Upper Boreal Highlands. Conversely, bear shrubs and moose shrubs were generally projected to be greater in cutblock sites than in caribou use sites. For moose saplings, we also observed general trends where the projected values in disturbance sites approached similar values to those in caribou use sites around 40 projected years.

4.4.3. Implications for management

Our model simulations indicate that in harvest and wildlife sites stand characteristics associated with overstory structure and timber supply (e.g., basal area, canopy cover, QMD, and SPH) are projected to exceed the values observed in caribou use sites relatively quickly. In some NSRs, projected values of basal area, canopy cover, and QMD in cutblocks exceeded those in caribou use sites by simulation year 10, which is quicker projected growth than in wildfire sites. Counts of coniferous saplings and CWD were projected to decrease over time, and these findings were consistent across NSRs. Counts of CWD were projected to reach similar values as in the caribou use sites, but projected counts of coniferous saplings reached values less than those in the caribou use sites. This could be an artefact of the mixedwood growth models we used; we did not include additional regeneration events in our simulations because we included empirical counts of saplings in the stand initialization event (Bokalo et al. 2013).

The projections for the forage groups were more variable among the different sites we sampled. These projections and accompanying implications can reflect the complexity of the landscape and the required management (Seidl et al. 2011; Whitman et al. 2017). Though important winter forage for caribou (caribou lichens) was projected to increase over time, the comparison of values in disturbance sites with those in caribou use sites varied among natural subregion – representative of different forest, climatic, and edaphic conditions (Natural Regions Committee 2006). Moreover, the trajectory of caribou lichens differed depending on disturbance type. We also observed varying trends in the abundance of moose shrub and bear forb groups. Therefore, the provisioning of future forage for caribou, moose, and bears will be largely dependent on the disturbance legacy and environmental conditions of the site. This is evidenced by the relative importance of disturbance type and NSR for explaining the variation of the projected data (Table A31). Strategic management of these forest ecosystems will need to take into account these factors when deciding which stand characteristics to support.

5. Synthesis

5.1. Synthesis

5.1.1. Stand characteristics of areas with documented use by woodland caribou in Alberta

Key findings:

- We described the stand and forage conditions at 256 plots that were used by caribou across approximately 88,900 km^2 in Alberta. See Table 5.1 for a summary description of those stand attributes.
- Generally, caribou use sites had lower stand basal area (mean 18.7 m^2 ha^{-1}), sites also had fewer deciduous trees (mean 17.8%), moderate QMD (mean 10.82 cm), and moderate canopy cover (mean 40.2%; Table 5.1).
- Caribou use sites had low to moderate percent cover of caribou forbs and lichens (mean 4.43% and 8.81% respectively), low to moderate percent cover of moose forage (1.4-10.8%), and low to moderate percent cover of bear forage (0.27-9.34%; Table 5.1).
- The percentage of deciduous trees at caribou use sites was greatest in the Central Mixedwood (Table 2.4).
- Caribou lichens were least abundant in the Central Mixedwood and Upper Foothills and most abundant in the Upper Boreal Highlands; abundance of caribou forbs was lowest in the Central Mixedwood and greatest in the Upper Boreal Highlands (Table 2.4).
- Moose forbs were most abundant in the Lower Boreal Highlands. Moose saplings and moose shrubs were not abundant at caribou use sites regardless of NSR (Table 2.4).
- Bear forbs were most abundant in the Upper Boreal Highlands and least abundant in the Central Mixedwood. Bear shrubs were scarce in all NSRs (Table 2.4).

Limitations:

- This study provides a summary of the characteristics of stands used by GPS-collared caribou. However, our data do not characterise forest stands within caribou ranges that caribou did not use. Also, we did not assess availability or selection of habitat by caribou (e.g., Resource Selection Functions; Johnson et al. 2004; DeCesare et al. 2012).
- Stand characteristic data were collected at caribou GPS locations between 2019 and 2022. This does not imply that areas where field data were not collected were unsuitable or not used by caribou. Caribou are at historically low densities across much of Alberta. These areas of low use may be important habitat in the future or following forest succession and improved forage conditions or reductions in predation risk. Also, these areas may be used less frequently for other life-history requisites, such as movement or migration (Theoret et al., 2022).

Table 5.1. Mean, standard error, and range (min. – max.) of stand characteristics measured in caribou use sites (all NSR data pooled together, n = 256).

Stand characteristic	Mean	Std. Error	Range
Basal area (BA.Alive; m^2 ha^{-1})	18.70	0.97	0 – 67.56
Deciduous basal area (BA.d.Alive; m^2 ha^{-1})	2.48	0.39	0 – 53.14
Coniferous basal area (BA.c.Alive; m^2 ha^{-1})	16.22	0.96	0 – 67.56
Deciduous trees (%)	17.80	2.05	0 – 100
QMD (cm)	10.82	0.28	0 – 26.84
SPH	1844.53	91.26	0 – 7000
Canopy cover (%)	40.20	1.72	0 – 94
Coniferous saplings (count)	50.52	3.19	0 – 243
CWD (count)	6.68	0.43	0 – 36
Soil depth (cm)	46.80	2.45	0.63 – 117
Caribou forbs (%)	4.43	0.41	0 – 43
Caribou lichens (%)	8.81	1.06	0 – 82
Moose forbs (%)	10.81	0.55	0 – 45
Moose saplings (count)	1.22	0.35	0 – 55
Moose shrubs (%)	1.40	0.24	0 – 41
Bear forbs (%)	9.34	0.55	0 – 44
Bear shrubs (%)	0.27	0.09	0 – 14

5.1.2. Comparing cutblock, wildfire, and caribou use sites

Key findings:

- In addition to the sampling of sites known to be used by GPS-collared caribou (N=256), we sampled 251 and 264 randomly selected sites that had experienced timber harvest and wildfire, respectively, over the past 40 years.
- Basal area, QMD, and canopy cover increased more rapidly in cutblocks compared to similarly aged wildfire sites in most NSRs (Figures 3.1, 3.3).
- Basal area of deciduous trees was generally greater in timber harvest sites compared to wildfire and caribou use sites (Figures 3.1, 3.2).
- Counts of coniferous saplings and CWD was generally greatest in wildfire sites until at least 10 years post-disturbance, and, in some cases, up to 30 years post-disturbance (Figure 3.3). Over time these counts declined and became similar to those in wildfire and caribou use sites (Figure 3.3).
- Soil depth in wildfire sites was similar to soil depths in caribou use sites (Figure 3.3).
- Caribou lichens were scarce following timber harvest and wildfire, and most abundant in caribou use sites (Figure 3.5).
- Moose saplings and moose shrubs were most abundant in young cutblock and wildfire sites (Figure 3.6). Bear shrubs were most abundant in cutblock sites (Figure 3.7).

Limitations:

- We did not collect field data from timber harvesting or wildfire sites older than 40 years (time since disturbance), so we were unable to compare cutblock and wildfire sites to similarly-aged caribou use sites.
- Although we sampled 771 sites across an extensive area of Alberta, we had an insufficient sample size to stratify the data by silvicultural practice in addition to NSR and age class. Future analyses should focus on the outcomes of silvicultural strategy for forest productivity and the successional response of forage for caribou, moose and bears.

5.1.3. Relationships between stand characteristics and forage groups among sites

Key findings:

- The relationships between stand characteristics and availability of forage for wildlife species differed depending on disturbance type. For example, deciduous basal area was negatively associated with caribou lichens in cutblocks, but there was no relationship between deciduous basal area and caribou lichens in wildfire sites (Figure 3.9).
- The relationships between stand characteristics and availability of forage also varied according to forage group. Stand characteristics associated with early seral forest (e.g., greater deciduous basal area) were associated with greater availability of moose and bear forage (moose saplings, moose shrubs, bear shrubs), and fewer caribou lichens in cutblocks (Figure 3.9).
- The relationships between stand characteristics and forage groups also differed among NSRs. For example, canopy cover had a negative effect on moose saplings in cutblock sites in the Central Mixedwood but had a positive effect on the same forage group in cutblock sites in the Upper Boreal Highlands (Figure 3.13).

Limitations:

- We observed considerable variation in the abundance of each forage group among sample plots even after controlling for differences associated with NSR and disturbance type. Given that variation, especially when considering the observed cover of terrestrial lichens, the statistical models had modest predictive ability. This is to be expected as statistical models represent average relationships and are typically poor predictors of highly variable ecological outcomes. Additional model covariates (e.g., silvicultural treatments, disturbance severity, distance to forest edge) may improve model fit.

5.1.4. Assessment of cutblock and wildfire sites for their ability to produce future woodland caribou habitat

Key findings:

- Timber supply variables, such as basal area (BA.Alive), QMD, and SPH, were projected to follow expected successional trends for the modelled forest types. For example, basal area and QMD were projected to increase to 30-40 m^2 ha^{-1} and 20 cm, respectively, and SPH was projected to decrease to around 1000 (Figures 4.2, 4.4, 4.5).
- Coniferous saplings and downed CWD were projected to decrease over time following wildfire and timber harvest (Figures 4.7, 4.8).
- Model projections suggested rapid ecological recovery following disturbance. Many of the stand characteristics (e.g., basal area, SPH, canopy cover, coniferous saplings) were projected to have similar values as in the older caribou use sites (all sites > 40 years) in as early as 10 projected years (Figures 4.2, 4.5, 4.6, 4.8).
- When comparing initial tree densities, the category with the lowest initial tree density (SPH < 1000) reached lower maximal basal area values, which were similar to those observed in caribou use sites (Figure 4.9).
- Projection times for the recovery of forage groups varied according to disturbance type and among NSR.
- Caribou lichens were projected to increase over time, while moose saplings, moose shrubs, and bear shrubs were projected to decrease over time in most NSRs (Figures 4.12, 4.14, 4.15, 4.17).

Limitations:

- We measured and assessed select components of caribou habitat: availability of forage for caribou, and proxies for presence of moose and bears (moose forage, bear forage). However, we did not include other components of caribou habitat in our analysis. A more complete analysis of caribou habitat would include disturbance associated with industrial features, topography, as well as the risk of predation from multiple predators.
- Our description of forage groups was based on the best available knowledge, but likely did not include all the components of the diet of caribou, moose, and bears. We also did not quantify the nutritional quality of the forage items that we did include (see Denryter et al. 2022).
- The recovery of forest stands within cutblock and wildfire sites are likely the product of numerous factors that we did not measure at field plots or include in the MGM model. Microclimate (e.g., precipitation, temperature, solar radiation), burn intensity and post-disturbance treatment, as examples, would likely be important determinants of the growth and successional trajectory of conifer and deciduous trees across the study area.

5.1.5. Recommendations and applications

Applications

- Our sample data and resulting statistical and projection models (e.g., MGM) provided some novel insights on differences in forest and forage conditions following timber harvest and wildfire as well as the trajectory of those forest attributes over time. For example, our data suggested that initial densities of 1000–2999 trees resulted in the greatest basal area of all tree types in cutblocks (Figure 4.9). At an initial density of 1000–2999 trees, the basal area of deciduous trees in cutblocks was generally less than at higher (≥ 3000) and lower (< 1000) initial tree densities (Figure 4.10).
- Based on our forage models, a reduction in deciduous basal area in cutblocks could have positive impacts for caribou lichens. Moreover, a reduction in deciduous basal area could also have negative impacts on forage for moose and bears.
- Although we could not assess stand and forage responses to silvicultural strategies, measures such as stand thinning or targeting specific planting densities could facilitate the development of forest overstory structure (e.g., canopy cover, SPH) that more closely resembles the structure observed at caribou use sites (see Tables 2.3, 5.1). The literature suggests that post-disturbance forest with relatively less canopy cover and basal area results in greater abundance of terrestrial lichens (e.g., Coxson and Marsh 2001; Hart and Chen 2008; Ray et al. 2015).

Final takeaways

For the range of stand characteristics we measured, we found that some metrics within cutblock and wildfire sites (e.g., basal area, QMD, canopy cover) were similar to those in caribou use sites relatively soon after disturbance but were also projected to exceed those values over time. Stands regenerating post-harvest or -wildfire were observed to be generally well stocked, and projected to develop into closed canopy stands with reasonable basal area and uniform DBH distribution. In contrast, the older caribou use sites, generally had lower basal area and more variable tree size. This likely reflected small-scale disturbance agents that resulted in patchy tree mortality, producing a forest that was vertically and horizontally more variable (Greene et al. 1999; McRae et al. 2001; Bartels et al. 2016).

A comprehensive assessment of viable caribou habitat should consider multiple factors and multiple scales. This study focused on select elements of caribou habitat, while excluding others, such as occurrence and density of competitors and predators, and the surrounding habitat matrix (DeCesare et al. 2010; Johnson et al. 2020). We measured several stand characteristics and determined the range of values in timber harvested stands, burned stands, and stands used by caribou. We found that the stand characteristics within caribou use sites were highly variable. Habitat used by caribou can include a diverse array of forest types with varying stand structure and composition (Stevenson et al. accepted) as caribou continually trade off predation risk and forage (Johnson et al. 2001; Avgar et al. 2015). We also note that although the caribou use sites were identified based on GPS data, and therefore inherently account for the multiple scales at which caribou make decisions about habitat selection (DeCesare et al. 2012), cutblock and wildfire sites did not consider those same factors. Even if a cutblock or wildfire site has forest and understory attributes similar to a caribou use site, it may not be used by caribou as they avoid disturbance at the landscape scale (Stevenson et al. accepted). Therefore, the characteristics within a disturbance, as well as the characteristics of the landscape surrounding the disturbance (e.g. terrain, forest type, densities of different disturbances) need to be considered when determining whether a disturbed area is or may be suitable caribou habitat into the future. Assessments of caribou habitat cannot be based on attributes of stand structure and composition alone but should also include other indicators of habitat like the availability of cover, the surrounding habitat, and the availability and quality of forage (Denryter et al. 2022).

Forage is a primary component of wildlife habitat (Waterhouse et al. 2011; Russell and Johnson 2019; Nobert et al. 2020; Cichowski et al. 2022) and influences wildlife distribution (Nielsen et al. 2010). It is important to understand how forest stand characteristics influence the availability of forage for caribou, and how they impact forage used by other wildlife species that interact with caribou: an apparent competitor (moose), and a predator (bears). By assessing forage for multiple species, we found that some stand characteristics were more beneficial for growth of forage for moose or bears, rather than caribou. For example, deciduous basal area in cutblocks was positively associated with moose and bear shrubs, but negatively associated with caribou lichens (Section 3.3.2). However, basal area of all tree types was negatively associated with all three forage groups in cutblocks (Section 3.3.2).

Management decisions should consider the complexity of stand-forage relationships, since interventions, such as thinning, could reduce forage for moose and bears, but also forage for caribou. Moreover, interventions designed to reduce forage availability for moose and bears could have negative impacts on the population and density of these species, and these species are a conservation concern in certain areas of Alberta (Alberta Grizzly Bear Recovery Team 2008; Lamy and Finnegan 2019). In areas where management will be applied decisions will need to consider the population status of target wildlife in these multispecies systems.

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APPENDIX A

fRI RESEARCH SILVICULTURE PROJECT – POTENTIAL SAMPLING STRATA

Document emailed to ARCKP members for feedback (Eric Neilson [NRCAN], Dave Hervieux [GoA], Gord Whitmore [Mercer], Wendy Crosina [Weyerhaeuser], Allan Bell [Tolko], Mark Tamas [Tolko], Elston Dzus [Alpac], Craig Dockrill [GoA], Matthew Wheatley [NRCAN], John Stadt [GoA], and Kristy Burke [ARCKP], 23 April 2021

1. ECOSITE STRATA FILTERED BY DOMINANT ECOSITE (HAS A > 5% AREA IN INDIVIDUAL POPULATIONS) GROUPED INTO **TEN YEAR** INTERVALS

We filtered out matching ecosite strata between cutblock and wildfire age classes

Cutblock strata populations indicates in which herds the corresponding cutblock strata occurs.

Fire strata populations indicates in which herds the corresponding fire strata occurs.

- In total there are **158** unique strata (79 for cutblocks and 79 for fire)
- If we sample 5 sites per strata, total number of sites would be **790** sites.

AGE CLASS	NATURAL SUBREGION	ECOSITE CODE	CUTBLOCK STRATA POPULATIONS									FIRE STRATA POPULATIONS								
			ESAR	WSAR	Nipisi	Red Earth	Chinchaga	Little	A La Peche	RRPC	Narraway	ESAR	WSAR	Nipisi	Red Earth	Chinchaga	Little Smoky	A La Peche	RRPC	Narraway
0-10y	CM	d																		
0-10y	CM	i																		
0-10y	CM	j																		
0-10y	CM	k																		
0-10y	LBH	c																		
0-10y	LBH	d																		
0-10y	LBH	h																		
0-10y	LF	d																		
0-10y	LF	e																		
0-10y	LF	f																		
0-10y	SA	d																		
0-10y	SA	e																		

AGE CLASS	NATURAL SUBREGION	ECOSITE CODE	CUTBLOCK STRATA POPULATIONS									FIRE STRATA POPULATIONS								
			ESAR	WSAR	Nipisi	Red Earth	Chinchaga	Little	A La Peche	RRPC	Narraway	ESAR	WSAR	Nipisi	Red Earth	Chinchaga	Little Smoky	A La Peche	RRPC	Narraway
0-10y	UB	c																		
0-10y	UB	d																		
0-10y	UF	c																		
0-10y	UF	d																		
0-10y	UF	e																		
0-10y	UF	k																		
0-10y	UF	l																		
11-20y	CM	d																		
11-20y	CM	i																		
11-20y	CM	j																		
11-20y	CM	k																		
11-20y	LBH	c																		
11-20y	LBH	d																		
11-20y	LBH	h																		
11-20y	LF	e																		
11-20y	LF	f																		
11-20y	SA	d																		
11-20y	SA	e																		
11-20y	UB	c																		
11-20y	UB	d																		
11-20y	UF	c																		
11-20y	UF	d																		
11-20y	UF	e																		
11-20y	UF	k																		
11-20y	UF	l																		
21-30y	CM	d																		
21-30y	CM	i																		
21-30y	CM	j																		
21-30y	CM	k																		
21-30y	LBH	c																		
21-30y	LBH	d																		
21-30y	LBH	h																		
21-30y	SA	e																		

AGE CLASS	NATURAL SUBREGION	ECOSITE CODE	CUTBLOCK STRATA POPULATIONS									FIRE STRATA POPULATIONS								
			ESAR	WSAR	Nipisi	Red Earth	Chinchaga	Little	A La Peche	RRPC	Narraway	ESAR	WSAR	Nipisi	Red Earth	Chinchaga	Little Smoky	A La Peche	RRPC	Narraway
21-30y	UB	c					■									■				
21-30y	UB	d					■									■				
21-30y	UF	c						■									■			
21-30y	UF	d						■			■						■			
21-30y	UF	e						■	■	■	■						■		■	
21-30y	UF	k						■									■			
31-40y	CM	d	■	■	■	■						■	■	■	■					
31-40y	CM	i	■	■	■	■						■	■	■	■					
31-40y	CM	j	■	■	■	■						■	■	■	■					
31-40y	CM	k		■									■							
31-40y	LBH	d					■									■				
31-40y	LBH	h				■	■					■			■	■				
31-40y	SA	e							■	■									■	
31-40y	UB	c					■									■				
31-40y	UB	d					■									■				
31-40y	UF	c						■									■			
31-40y	UF	d						■									■			
31-40y	UF	e						■	■	■	■						■		■	
31-40y	UF	k						■									■			
31-40y	UF	l						■												
41-50y	CM	d			■	■						■	■	■	■					
41-50y	CM	i			■	■						■	■	■	■					
41-50y	CM	j			■	■						■	■	■	■					
41-50y	LBH	c	■									■								
41-50y	LBH	d					■									■				
41-50y	LBH	h	■				■					■			■	■				
51-60y	CM	d			■	■						■	■	■	■					
51-60y	CM	i				■						■	■	■	■					
51-60y	CM	j				■						■	■	■	■					
51-60y	LBH	c	■									■								
51-60y	LBH	d					■									■				
51-60y	LBH	h	■				■					■			■	■				
51-60y	SA	e							■										■	

AGE CLASS	NATURAL SUBREGION	ECOSITE CODE	CUTBLOCK STRATA POPULATIONS									FIRE STRATA POPULATIONS								
			ESAR	WSAR	Nipisi	Red Earth	Chinchaga	Little	A La Peche	RRPC	Narraway	ESAR	WSAR	Nipisi	Red Earth	Chinchaga	Little Smoky	A La Peche	RRPC	Narraway
51-60y	UF	e																		

If we group into 5 year intervals

- In total there are **244** unique strata (122 for cutblocks and 122 for fire)
- If we sample 5 sites per strata, total number of sites would be **1220** sites.

2. Unique burn class (severity) strata filtered by dominant ecosite (ecosite has a > 5% area in individual populations) grouped into **ten year** intervals:

Unique burn class strata combinations within matching fire, cutblock strata.

- **159** unique strata

AGE_CLASS	BURN_CLASS	NSR	ECOSITE_CODE	STRATA_HERDS								
				ESAR	WSAR	Nipisi	Red Earth	Chinchaga	Little Smoky	A La Peche	RRPC	Narraway
0-10y	1	CM	d									
0-10y	1	CM	i									
0-10y	1	CM	j									
0-10y	1	CM	k									
0-10y	1	LBH	c									
0-10y	1	LBH	d									
0-10y	1	LBH	h									
0-10y	1	SA	e									
0-10y	1	UB	c									
0-10y	1	UB	d									
0-10y	1	UF	d									
0-10y	1	UF	e									
0-10y	1	UF	k									
0-10y	2	CM	d									
0-10y	2	CM	i									
0-10y	2	CM	j									

AGE_CLASS	BURN_CLASS	NSR	ECOSITE_CODE	STRATA_HERDS								
				ESAR	WSAR	Nipisi	Red Earth	Chinchaga	Little Smoky	A La Peche	RRPC	Narraway
0-10y	2	CM	k									
0-10y	2	LBH	c									
0-10y	2	LBH	d									
0-10y	2	LBH	h									
0-10y	2	UB	c									
0-10y	2	UB	d									
0-10y	3	CM	d									
0-10y	3	CM	i									
0-10y	3	CM	j									
0-10y	3	CM	k									
0-10y	3	LBH	c									
0-10y	3	LBH	d									
0-10y	3	LBH	h									
0-10y	3	SA	e									
0-10y	3	UB	c									
0-10y	3	UB	d									
0-10y	3	UF	e									
0-10y	4	CM	d									
0-10y	4	CM	i									
0-10y	4	CM	j									
0-10y	4	CM	k									
0-10y	4	LBH	c									
0-10y	4	LBH	d									
0-10y	4	LBH	h									
0-10y	4	SA	e									
0-10y	4	UB	c									
0-10y	4	UB	d									
0-10y	4	UF	e									
0-10y	5	CM	d									
0-10y	5	CM	i									
0-10y	5	CM	j									
0-10y	5	CM	k									
0-10y	5	LBH	c									
0-10y	5	LBH	d									
0-10y	5	LBH	h									
0-10y	5	LF	d									
0-10y	5	LF	e									
0-10y	5	LF	f									
0-10y	5	SA	d									
0-10y	5	SA	e									
0-10y	5	UB	c									
0-10y	5	UB	d									
0-10y	5	UF	c									
0-10y	5	UF	d									
0-10y	5	UF	e									
0-10y	5	UF	k									

AGE_CLASS	BURN_CLASS	NSR	ECOSITE_CODE	STRATA_HERDS								
				ESAR	WSAR	Nipisi	Red Earth	Chinchaga	Little Smoky	A La Peche	RRPC	Narraway
0-10y	5	UF	l									
11-20y	1	CM	d									
11-20y	1	CM	i									
11-20y	1	CM	j									
11-20y	1	CM	k									
11-20y	1	LBH	c									
11-20y	1	LBH	d									
11-20y	1	LBH	h									
11-20y	1	UB	c									
11-20y	1	UB	d									
11-20y	1	UF	c									
11-20y	1	UF	d									
11-20y	1	UF	e									
11-20y	2	CM	d									
11-20y	2	CM	i									
11-20y	2	CM	j									
11-20y	2	LBH	c									
11-20y	2	LBH	h									
11-20y	2	UB	c									
11-20y	3	LBH	c									
11-20y	5	CM	d									
11-20y	5	CM	i									
11-20y	5	CM	j									
11-20y	5	CM	k									
11-20y	5	LBH	c									
11-20y	5	LBH	d									
11-20y	5	LBH	h									
11-20y	5	LF	e									
11-20y	5	LF	f									
11-20y	5	SA	d									
11-20y	5	SA	e									
11-20y	5	UB	c									
11-20y	5	UB	d									
11-20y	5	UF	c									
11-20y	5	UF	d									
11-20y	5	UF	e									
11-20y	5	UF	k									
11-20y	5	UF	l									
11-20y	9	CM	d									
11-20y	9	CM	i									
11-20y	9	CM	j									
11-20y	9	LBH	c									
11-20y	9	LBH	h									
21-30y	5	CM	d									
21-30y	5	CM	i									
21-30y	5	CM	j									

AGE_CLASS	BURN_CLASS	NSR	ECOSITE_CODE	STRATA_HERDS								
				ESAR	WSAR	Nipisi	Red Earth	Chinchaga	Little Smoky	A La Peche	RRPC	Narraway
21-30y	5	CM	k									
21-30y	5	LBH	c									
21-30y	5	LBH	d									
21-30y	5	LBH	h									
21-30y	5	SA	e									
21-30y	5	UB	c									
21-30y	5	UB	d									
21-30y	5	UF	c									
21-30y	5	UF	d									
21-30y	5	UF	e									
21-30y	5	UF	k									
21-30y	9	CM	d									
21-30y	9	CM	i									
21-30y	9	CM	j									
21-30y	9	LBH	c									
21-30y	9	LBH	d									
21-30y	9	LBH	h									
31-40y	5	CM	d									
31-40y	5	CM	i									
31-40y	5	CM	j									
31-40y	5	CM	k									
31-40y	5	LBH	d									
31-40y	5	LBH	h									
31-40y	5	SA	e									
31-40y	5	UB	c									
31-40y	5	UB	d									
31-40y	5	UF	c									
31-40y	5	UF	d									
31-40y	5	UF	e									
31-40y	5	UF	k									
31-40y	5	UF	l									
41-50y	5	CM	d									
41-50y	5	CM	i									
41-50y	5	CM	j									
41-50y	5	LBH	c									
41-50y	5	LBH	d									
41-50y	5	LBH	h									
41-50y	9	LBH	c									
41-50y	9	LBH	h									
51-60y	5	CM	d									
51-60y	5	CM	i									
51-60y	5	CM	j									
51-60y	5	LBH	c									
51-60y	5	LBH	d									
51-60y	5	LBH	h									
51-60y	5	SA	e									

AGE_CLASS	BURN_CLASS	NSR	ECOSITE_CODE	STRATA_HERDS								
				ESAR	WSAR	Nipisi	Red Earth	Chinchaga	Little Smoky	A La Peche	RRPC	Narraway
51-60y	5	UF	e									
51-60y	9	CM	d									
51-60y	9	CM	i									
51-60y	9	CM	j									
51-60y	9	UF	e									

3. Unique herbicide strata (applied yes, no) filtered by dominant ecosite (ecosite has a > 5% area in individual populations) grouped into ten year intervals:

Unique herbicide strata combinations within matching fire, cutblock strata.

- **82** unique strata

AGE_CLASS	HERBICIDE	NATURAL_SUBREGION	ECOSITE_CODE	STRATA_HERDS								
				ESAR	WSAR	Nipisi	Red Earth	Chinchaga	Little Smoky	A La Peche	RRPC	Narraway
0-10y	Y	CM	d									
0-10y	Y	CM	i									
0-10y	Y	CM	j									
0-10y	Y	CM	k									
0-10y	Y	LBH	c									
0-10y	Y	LBH	d									
0-10y	Y	LBH	h									
0-10y	Y	LF	d									
0-10y	Y	LF	e									
0-10y	Y	LF	f									
0-10y	Y	SA	e									
0-10y	Y	UB	c									
0-10y	Y	UB	d									
0-10y	Y	UF	c									
0-10y	Y	UF	d									
0-10y	Y	UF	e									
0-10y	Y	UF	k									
0-10y	Y	UF	l									
11-20y	N	CM	d									

AGE_CLASS	HERBICIDE	NATURAL_SUBREGION	ECOSITE_CODE	STRATA_HERDS								
				ESAR	WSAR	Nipisi	Red Earth	Chinchaga	Little Smoky	A La Peche	RRPC	Narraway
11-20y	N	CM	i									
11-20y	N	CM	j									
11-20y	N	LF	e									
11-20y	N	SA	d									
11-20y	N	SA	e									
11-20y	N	UF	c									
11-20y	N	UF	d									
11-20y	N	UF	e									
11-20y	N	UF	k									
11-20y	N	UF	l									
11-20y	Y	CM	d									
11-20y	Y	CM	i									
11-20y	Y	CM	j									
11-20y	Y	CM	k									
11-20y	Y	LBH	c									
11-20y	Y	LBH	h									
11-20y	Y	LF	e									
11-20y	Y	LF	f									
11-20y	Y	UB	c									
11-20y	Y	UB	d									
11-20y	Y	UF	d									
11-20y	Y	UF	e									
21-30y	N	SA	e									
21-30y	N	UF	c									
21-30y	N	UF	d									
21-30y	N	UF	e									
21-30y	N	UF	k									
21-30y	Y	CM	d									
21-30y	Y	CM	i									
21-30y	Y	CM	j									
21-30y	Y	LBH	d									
21-30y	Y	LBH	h									
21-30y	Y	SA	e									
21-30y	Y	UB	c									
21-30y	Y	UB	d									
21-30y	Y	UF	e									
31-40y	N	CM	d									
31-40y	N	CM	i									
31-40y	N	CM	j									
31-40y	N	SA	e									
31-40y	N	UF	e									
31-40y	Y	CM	d									
31-40y	Y	CM	i									
31-40y	Y	CM	j									
31-40y	Y	CM	k									
31-40y	Y	LBH	d									
31-40y	Y	LBH	h									
41-50y	N	CM	d									

AGE_CLASS	HERBICIDE	NATURAL_SUBREGION	ECOSITE_CODE	STRATA_HERDS								
				ESAR	WSAR	Nipisi	Red Earth	Chinchaga	Little Smoky	A La Peche	RRPC	Narraway
41-50y	N	CM	i									
41-50y	N	CM	j									
41-50y	N	LBH	c									
41-50y	N	LBH	h									
41-50y	Y	LBH	d									
41-50y	Y	LBH	h									
51-60y	N	CM	d									
51-60y	N	CM	i									
51-60y	N	CM	j									
51-60y	N	LBH	c									
51-60y	N	LBH	h									
51-60y	N	SA	e									
51-60y	N	UF	e									
51-60y	Y	LBH	d									
51-60y	Y	LBH	h									

4. Unique herbicide application method strata combinations within matching fire, cutblock strata.

- **72** unique strata

AGE_CLASS	APPLICATION_METHOD	APPLICATION_YEAR	NATURAL_SUBREGION	ECOSITE_CODE	STRATA_HERDS								
					ESAR	WSAR	Nipisi	Red Earth	Chinchaga	Little Smoky	A La Peche	RRPC	Narraway
0-10y	AERIAL	2011-2020	CM	d									
0-10y	AERIAL	2011-2020	CM	i									
0-10y	AERIAL	2011-2020	CM	j									
0-10y	AERIAL	2011-2020	CM	k									
0-10y	AERIAL	2011-2020	LBH	c									
0-10y	AERIAL	2011-2020	LBH	d									
0-10y	AERIAL	2011-2020	LBH	h									
0-10y	AERIAL	2011-2020	LF	d									
0-10y	AERIAL	2011-2020	LF	e									
0-10y	AERIAL	2011-2020	LF	f									
0-10y	AERIAL	2011-2020	SA	e									
0-10y	AERIAL	2011-2020	UB	c									
0-10y	AERIAL	2011-2020	UB	d									

AGE_CLASS	APPLICATION_METHOD	APPLICATION_YEAR	NATURAL_SUBREGION	ECOSITE_CODE	STRATA_HERDS								
					ESAR	WSAR	Nipisi	Red Earth	Chinchaga	Little Smoky	A La Peche	RRPC	Narraway
0-10y	AERIAL	2011-2020	UF	c									
0-10y	AERIAL	2011-2020	UF	d									
0-10y	AERIAL	2011-2020	UF	e									
0-10y	AERIAL	2011-2020	UF	k									
0-10y	AERIAL	2011-2020	UF	l									
0-10y	GROUND	2011-2020	CM	d									
0-10y	GROUND	2011-2020	CM	i									
0-10y	GROUND	2011-2020	CM	j									
0-10y	GROUND	2011-2020	CM	k									
0-10y	GROUND	2011-2020	LBH	d									
0-10y	GROUND	2011-2020	LBH	h									
0-10y	GROUND	2011-2020	LF	e									
0-10y	GROUND	2011-2020	LF	f									
0-10y	GROUND	2011-2020	UB	c									
0-10y	GROUND	2011-2020	UB	d									
0-10y	GROUND	2011-2020	UF	c									
0-10y	GROUND	2011-2020	UF	d									
0-10y	GROUND	2011-2020	UF	e									
0-10y	GROUND	2011-2020	UF	k									
11-20y	AERIAL	2001-2010	CM	d									
11-20y	AERIAL	2001-2010	CM	i									
11-20y	AERIAL	2001-2010	CM	k									
11-20y	AERIAL	2011-2020	CM	d									
11-20y	AERIAL	2011-2020	CM	i									
11-20y	AERIAL	2011-2020	CM	j									
11-20y	AERIAL	2011-2020	LBH	c									
11-20y	AERIAL	2011-2020	LBH	h									
11-20y	AERIAL	2011-2020	LF	e									
11-20y	AERIAL	2011-2020	LF	f									
11-20y	AERIAL	2011-2020	UB	c									
11-20y	AERIAL	2011-2020	UB	d									
11-20y	AERIAL	2011-2020	UF	d									
11-20y	AERIAL	2011-2020	UF	e									
11-20y	GROUND	2011-2020	CM	d									
11-20y	GROUND	2011-2020	CM	i									
21-30y	AERIAL	2001-2010	LBH	d									
21-30y	AERIAL	2001-2010	LBH	h									
21-30y	AERIAL	2001-2010	SA	e									
21-30y	AERIAL	2001-2010	UB	c									
21-30y	AERIAL	2001-2010	UB	d									
21-30y	AERIAL	2001-2010	UF	e									
21-30y	GROUND	1991-2000	CM	d									
21-30y	GROUND	1991-2000	CM	i									
21-30y	GROUND	2001-2010	CM	d									

AGE_CLASS	APPLICATION_METHOD	APPLICATION_YEAR	NATURAL_SUBREGION	ECOSITE_CODE	STRATA_HERDS								
					ESAR	WSAR	Nipisi	Red Earth	Chinchaga	Little Smoky	A La Peche	RRPC	Narraway
21-30y	GROUND	2001-2010	CM	i									
21-30y	GROUND	2001-2010	CM	j									
21-30y	GROUND	2001-2010	LBH	h									
31-40y	AERIAL	2001-2010	LBH	d									
31-40y	AERIAL	2001-2010	LBH	h									
31-40y	GROUND	1991-2000	CM	d									
31-40y	GROUND	2001-2010	CM	d									
31-40y	GROUND	2001-2010	CM	i									
31-40y	GROUND	2001-2010	CM	j									
31-40y	GROUND	2001-2010	CM	k									
31-40y	GROUND	2001-2010	LBH	d									
41-50y	GROUND	2001-2010	LBH	d									
41-50y	GROUND	2001-2010	LBH	h									
51-60y	AERIAL	2001-2010	LBH	d									
51-60y	AERIAL	2001-2010	LBH	h									

APPENDIX B

Table A1: Tree species measured within sampling plots in the summers of 2021 and 2022 within cutblocks, wildfires, and caribou use sites used to assess differences among harvested and burned stands, and stands caribou use, in Alberta, Canada.

Common name	Scientific name
Lodgepole pine	*Pinus contorta*
Jack pine	*Pinus banksiana*
White spruce	*Picea glauca*
Black spruce	*Picea mariana*
Engelmann spruce	*Picea engelmannii*
Unknown spruce	*Picea spp*.
Balsam fir	*Abies balsamea*
Douglas-fir	*Pseudotsuga menziesii*
Subalpine fir	*Abies lasiocarpa*
Unknown fir	*Abies spp.*
Balsam poplar	*Populus balsamifera*
Trembling aspen	*Populus tremuloides*
Tamarack	*Larix laricina*
Paper birch	*Betula papyrifera*

Table A2: Target large shrub species measured within sampling plots in the summers of 2021 and 2022 within cutblocks, wildfires, and caribou use sites used to assess differences among harvested and burned stands, and stands caribou use, in Alberta, Canada.

Common name	Scientific name
Alnus spp.	Alder
Betula glandulosum	Bog Birch
Ribes spp.	Gooseberries and Currants
Salix spp.	Willow
Viburnum edule	Low Bush Cranberry
Amelanchier alnifolia	Saskatoon
Lonicera involucrata	Bracted Honeysuckle
Cornus stolonifera	Cornus sericea; Red Osier Dogwood
Corylus cornuta	Beaked Hazelnut
Prunus virginiana	Choke Cherry
Rosa spp.	Rose
Shepherdia canadensis	Buffaloberry
Symphoricarpos albus	Snowberry
Eleagnus commutata	Wolf Willow
Potentilla fruticosa	Pentaphylloides floribunda; Shrubby Cinquefoil

Table A3. Target dwarf shrubs, forbs, gramminoids, grasses, and lichens measured within sampling plots in the summers of 2021 and 2022 within cutblocks, wildfires, and caribou use sites used to assess differences among harvested and burned stands, and stands caribou use, in Alberta, Canada.

Common name	Scientific name
Dwarf shrubs	
Birch-Leaved Spiraea	Spiraea betulifolia
Sarsaparilla	Aralia nudicaulis
Raspberry	Rubus idaeus
Labrador Tea	Rhododendron groenlandicum
Blueberries	Vaccinium spp.
Common juniper	*Juniperus communis*
Forbs, gramminoids, grasses, lichens	
Sedges	Carex spp.
Fireweed	Chamerion spp.
Horsetails	Equisetum spp.
Clover	Trifolium spp.
Alfalfa	Medicago spp.
Canada Reed Grass	Calamagrostis canadensis
Hairy Wildrye	Elymus innovates
Bunchberry	Cornus canadensis
Wild Strawberry	Fragaria virginiana
Chickpea milkvetch	*Astragalus cicer*
Creamy Peavine	Lathyrus ochroleucus
Bluebells	Mertensia spp.
Feathermosses	Pleurozium spp.
Peat Mosses	Sphagnum spp.
Icelandmoss	Cetraria spp
Reindeer Lichen	Cladina spp.
Cladonia or Cup Lichen	Cladonia spp.
Ragged Lichen	Flavocetraria spp.
Pelt Lichen	Peltigera spp.
Coral Lichen	Stereocaulon spp.
Mushrooms	
Northern naugehyde liverwort.	*Ptilidium ciliare*

Supporting tables (Chapter 2)

Table A4. Coefficient estimates from linear regression models (described in 2.2.2) testing the effect of natural subregion on stand characteristics. Deviation coding was used for coefficients. Significance is displayed in bold. 2.5% and 97.5% CI refer to the lower and upper confidence intervals.

Variable	Coefficient	Estimate	Std. Error	2.5% CI	97.5% CI	t value	*P-value*
Basal area (BA.Alive)	Intercept	18.680	1.138	16.440	20.921	16.420	**<0.001**
	Central Mixedwood	-7.655	1.698	-11.000	-4.311	-4.508	**<0.001**
	Upper Foothills	4.484	1.502	1.526	7.442	2.985	**0.003**
	Lower Boreal Highlands	-1.070	1.823	-4.661	2.521	-0.587	0.558
	Upper Boreal Highlands	4.241	2.658	-0.994	9.477	1.596	0.112
Deciduous basal area (BA.d.Alive)	Intercept	2.534	0.456	1.637	3.431	5.562	**<0.001**
	Central Mixedwood	3.098	0.680	1.758	4.437	4.556	**<0.001**
	Upper Foothills	-2.064	0.601	-3.249	-0.879	-3.432	**<0.001**
	Lower Boreal Highlands	0.798	0.730	-0.640	2.236	1.093	0.276
	Upper Boreal Highlands	-1.831	1.064	-3.928	0.265	-1.721	0.087
Coniferous basal area (BA.c.Alive)	Intercept	16.147	1.046	14.087	18.206	15.438	**<0.001**
	Central Mixedwood	-10.753	1.561	-13.827	-7.679	-6.888	**<0.001**
	Upper Foothills	6.548	1.381	3.828	9.267	4.742	**<0.001**
	Lower Boreal Highlands	-1.868	1.676	-5.169	1.434	-1.114	0.266
	Upper Boreal Highlands	6.073	2.444	1.260	10.886	2.485	**0.014**
QMD	Intercept	10.588	0.329	9.941	11.235	32.223	**<0.001**
	Central Mixedwood	-1.730	0.490	-2.696	-0.764	-3.528	**<0.001**
	Upper Foothills	1.709	0.434	0.854	2.563	3.939	**<0.001**
	Lower Boreal Highlands	-0.459	0.527	-1.497	0.578	-0.872	0.384
	Upper Boreal Highlands	0.481	0.768	-1.031	1.993	0.626	0.532
SPH	Intercept	1978.694	111.114	1759.865	2197.524	17.808	**<0.001**
	Central Mixedwood	-341.013	165.854	-667.649	-14.377	-2.056	**0.041**
	Upper Foothills	-90.975	146.706	-379.902	197.952	-0.620	0.536
	Lower Boreal Highlands	-247.213	178.098	-597.963	103.538	-1.388	0.166
	Upper Boreal Highlands	679.201	259.626	167.888	1190.513	2.616	**0.009**
Canopy cover	Intercept	42.130	2.073	38.048	46.212	20.326	**<0.001**
	Central Mixedwood	-9.724	3.094	-15.817	-3.631	-3.143	**0.002**
	Upper Foothills	1.407	2.737	-3.982	6.797	0.514	0.608
	Lower Boreal Highlands	-4.014	3.322	-10.557	2.529	-1.208	0.228
	Upper Boreal Highlands	12.331	4.843	2.793	21.869	2.546	**0.011**
Coniferous saplings	Intercept	54.974	3.871	47.350	62.598	14.201	**<0.001**
	Central Mixedwood	-12.626	5.778	-24.006	-1.247	-2.185	**0.030**
	Upper Foothills	-9.158	5.111	-19.224	0.907	-1.792	0.074
	Lower Boreal Highlands	10.285	6.205	-1.935	22.505	1.658	0.099
	Upper Boreal Highlands	11.500	9.045	-6.314	29.313	1.271	0.205
Soil depth	Intercept	42.659	2.606	37.528	47.791	16.373	**<0.001**

	Central Mixedwood	34.375	3.889	26.716	42.034	8.839	**<0.001**
	Upper Foothills	-7.971	3.440	-14.746	-1.196	-2.317	**0.021**
	Lower Boreal Highlands	2.794	4.176	-5.430	11.019	0.669	0.504
	Upper Boreal Highlands	-29.199	6.088	-41.189	-17.209	-4.796	**<0.001**

Table A5. Coefficient estimates from negative binomial count models (described in 2.2.2) testing the effect of natural subregion on coarse woody debris (CWD), caribou lichens, and caribou forbs. Reference category is 'Central Mixedwood.' Significance is displayed in bold. 2.5% and 97.5% CI refer to the lower and upper confidence intervals.

Variable	Coefficient	Estimate	Std. Error	2.5% CI	97.5% CI	z value	*P-value*
CWD	Intercept	1.785	0.082	1.628	1.952	21.665	**<0.001**
	Central Mixedwood	-0.406	0.125	-0.651	-0.159	-3.241	**0.001**
	Upper Foothills	0.389	0.108	0.177	0.600	3.620	**<0.001**
	Lower Boreal Highlands	-0.025	0.132	-0.281	0.238	-0.187	0.852
	Upper Boreal Highlands	0.041	0.192	-0.318	0.438	0.215	0.830
Caribou forbs	Intercept	1.440	0.114	1.226	1.674	12.645	**<0.001**
	Central Mixedwood	-0.830	0.177	-1.175	-0.479	-4.696	**<0.001**
	Upper Foothills	0.301	0.150	0.004	0.593	2.012	**0.044**
	Lower Boreal Highlands	-0.091	0.183	-0.445	0.277	-0.497	0.619
	Upper Boreal Highlands	0.620	0.261	0.145	1.180	2.372	**0.018**
Caribou lichens	Intercept	2.280	0.135	2.030	2.564	16.855	**<0.001**
	Central Mixedwood	-0.746	0.204	-1.144	-0.337	-3.652	**<0.001**
	Upper Foothills	-0.971	0.181	-1.332	-0.618	-5.371	**<0.001**
	Lower Boreal Highlands	0.554	0.216	0.139	0.994	2.564	**0.010**
	Upper Boreal Highlands	1.162	0.314	0.607	1.857	3.705	**<0.001**
Moose forbs	Intercept	2.362	0.061	2.244	2.484	38.599	**<0.001**
	Central Mixedwood	0.100	0.091	-0.077	0.279	1.105	0.269
	Upper Foothills	-0.235	0.081	-0.395	-0.076	-2.895	**0.004**
	Lower Boreal Highlands	0.391	0.096	0.204	0.582	4.069	**<0.001**
	Upper Boreal Highlands	-0.256	0.145	-0.531	0.037	-1.772	0.076
Moose saplings	Intercept	0.201	0.343	NA	NA	0.585	0.558
	Central Mixedwood	0.130	0.511	NA	NA	0.253	0.800
	Upper Foothills	-0.912	0.459	NA	NA	-1.987	**0.047**
	Lower Boreal Highlands	0.708	0.546	NA	NA	1.296	0.195
	Upper Boreal Highlands	0.074	0.801	NA	NA	0.092	0.927
Moose shrubs	Intercept	0.220	0.142	-0.052	0.510	1.545	0.122
	Central Mixedwood	0.670	0.204	0.273	1.075	3.291	**0.001**
	Upper Foothills	-0.949	0.201	-1.347	-0.557	-4.723	**<0.001**
	Lower Boreal Highlands	0.553	0.219	0.131	0.992	2.531	**0.011**
	Upper Boreal Highlands	-0.274	0.338	-0.911	0.431	-0.812	0.417
Bear forbs	Intercept	2.323	0.071	2.187	2.467	32.619	**<0.001**
	Central Mixedwood	-0.446	0.109	-0.658	-0.231	-4.103	**<0.001**
	Upper Foothills	-0.132	0.095	-0.318	0.053	-1.389	0.165
	Lower Boreal Highlands	0.092	0.114	-0.130	0.319	0.802	0.422
	Upper Boreal Highlands	0.485	0.164	0.178	0.825	2.951	**0.003**
Bear shrubs	Intercept	-1.556	0.345	-2.193	-0.823	-4.509	**<0.001**
	Central Mixedwood	-0.280	0.512	-1.245	0.824	-0.547	0.584
	Boreal highlands	1.158	0.482	0.255	2.205	2.402	**0.016**
Bear shrubs	Upper Foothills	-0.877	0.470	-1.809	0.066	-1.869	0.062

Supporting figures (Chapter 2)

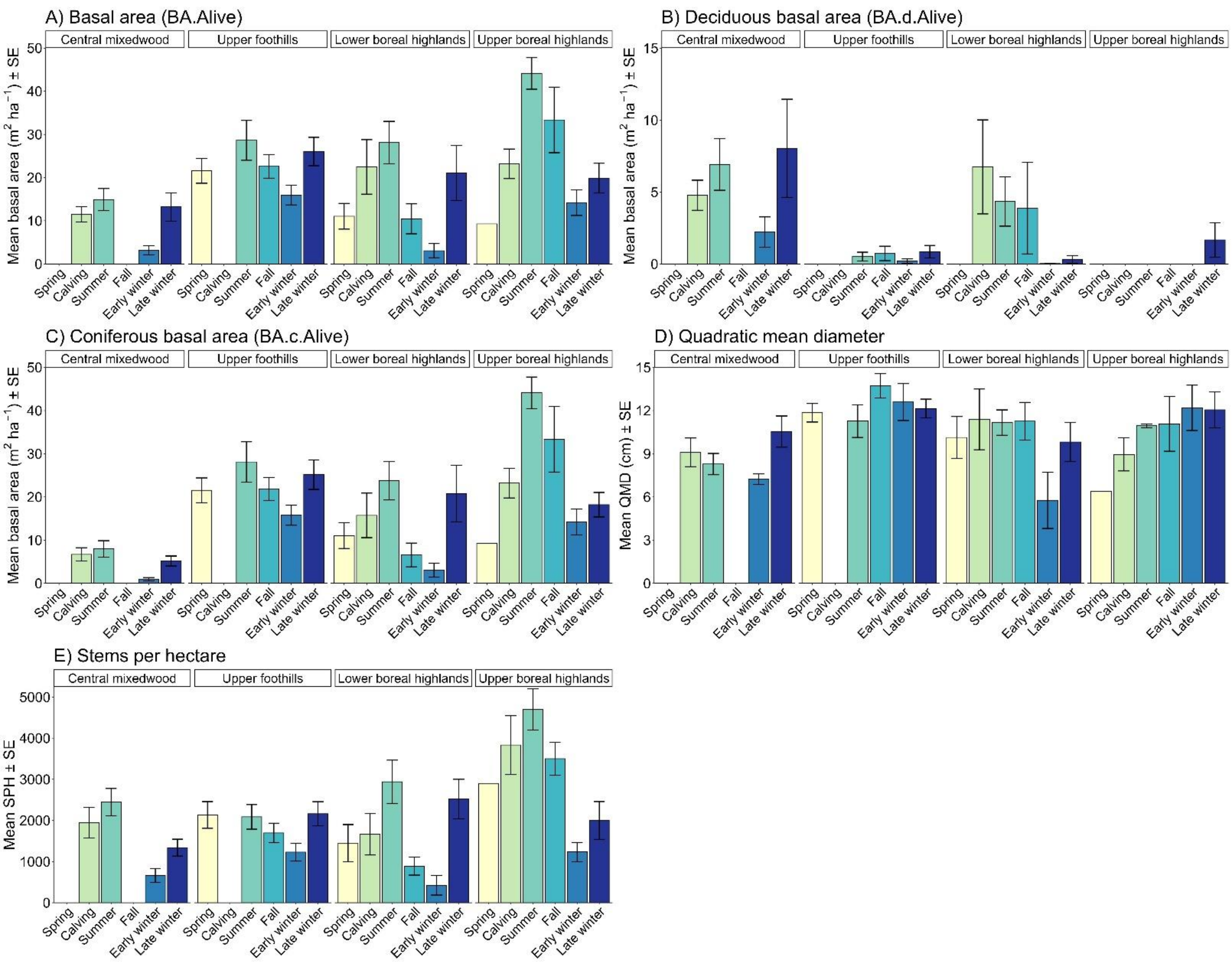

Figure A1. Mean values of stand characteristics A) Basal area (BA.Alive), B) Deciduous basal area (BA.d.Alive), C) Coniferous basal area (BA.c.Alive), D) Quadratic mean diameter (QMD), and E) Stems per hectare (SPH) compared between seasons (caribou use) across natural subregions. Error bars represent standard error (SE) of the mean. Data includes caribou use sites only. Some missing columns (e.g., 'spring' and 'fall' in Central Mixedwood, 'calving' in Upper Foothills) represent 0 sites sampled.

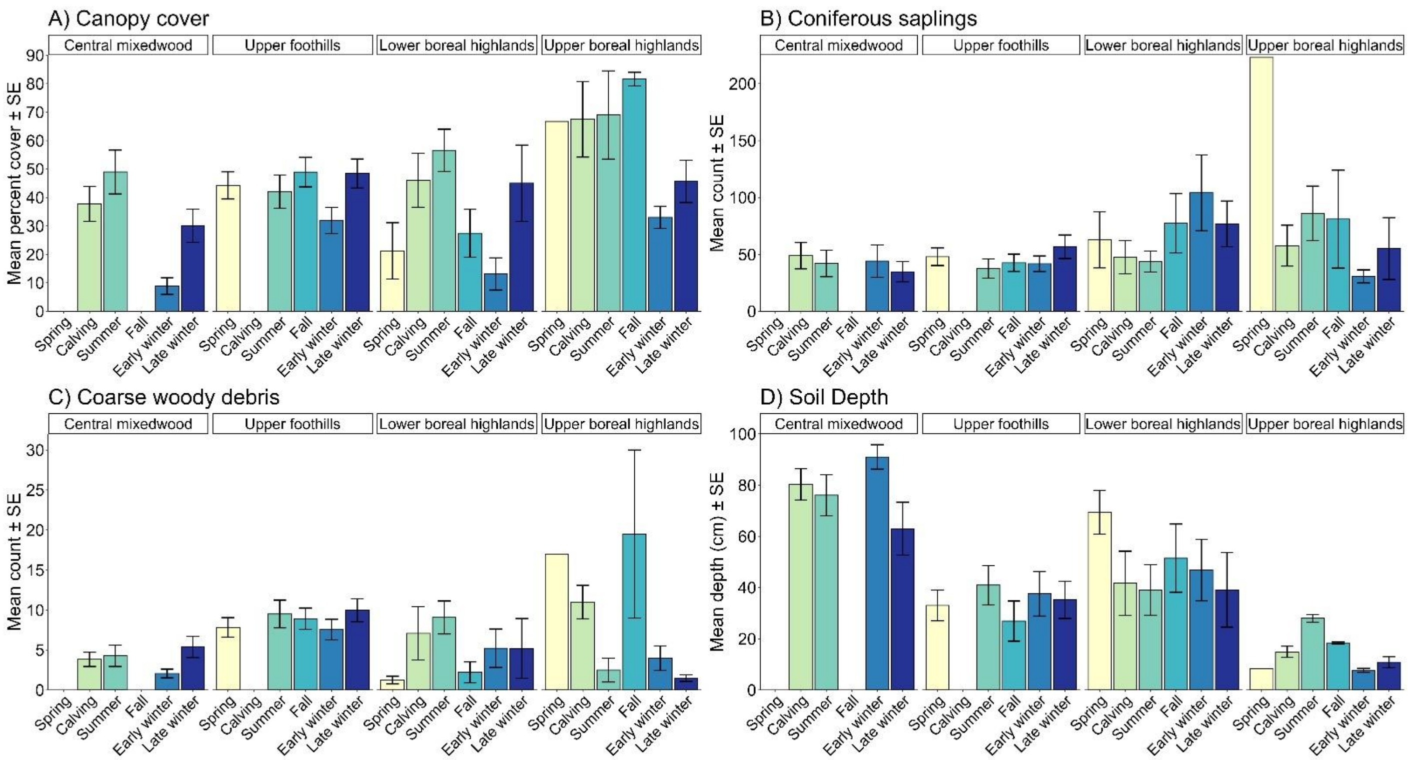

Figure A2. Mean values of stand characteristics A) Canopy cover, B) Coniferous saplings (count), C) Coarse woody debris (CWD), and D) Soil depth compared between seasons (caribou use) across natural subregions. Error bars represent standard error (SE) of the mean. Data includes caribou use sites only. Some missing columns (e.g., 'spring' and 'fall' in Central Mixedwood, 'calving' in Upper Foothills) represent 0 sites sampled.

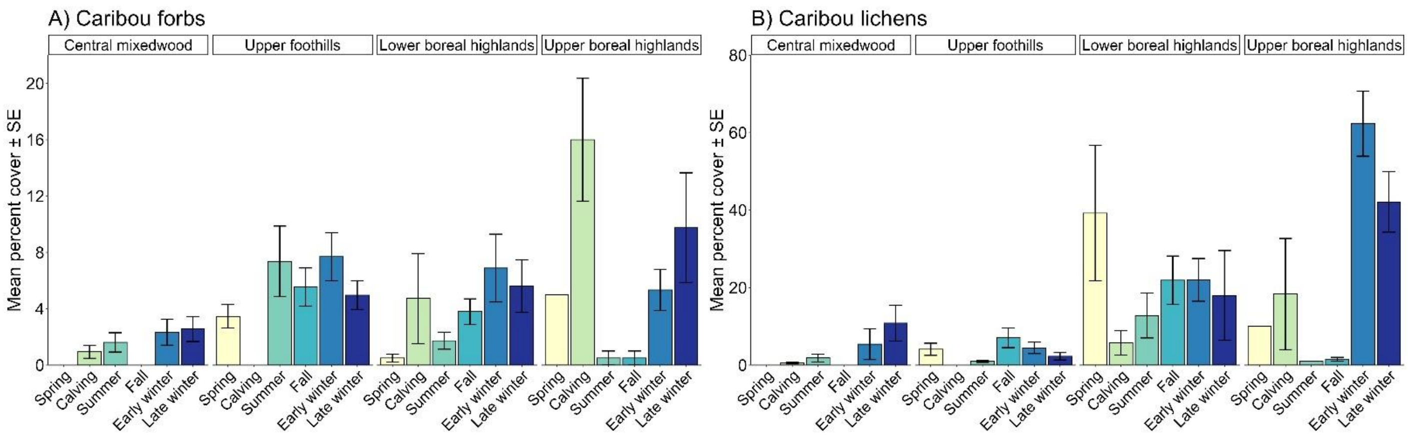

Figure A3. Mean values of forage groups A) Caribou forbs, and B) Caribou lichens compared between seasons (caribou use) across natural subregions. Error bars represent standard error (SE) of the mean. Data includes caribou use sites only. Some missing columns (e.g., 'spring' and 'fall' in Central Mixedwood, 'calving' in Upper Foothills) represent 0 sites sampled.

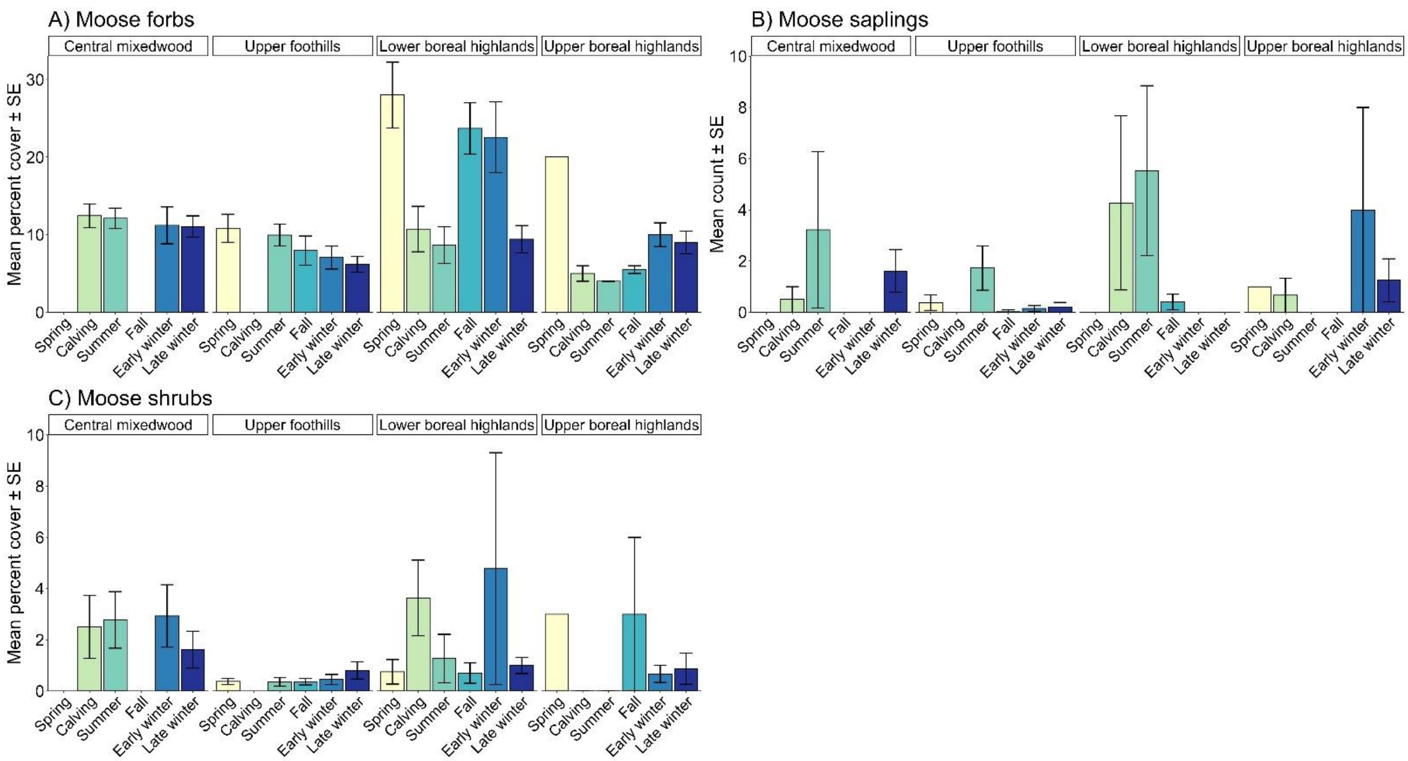

Figure A4. Mean values of forage groups A) Moose forbs, B) Moose saplings, and C) Moose shrubs compared between seasons (caribou use) across natural subregions. Error bars represent standard error (SE) of the mean. Data includes caribou use sites only. Some missing columns (e.g., 'spring' and 'fall' in Central Mixedwood, 'calving' in Upper Foothills) represent 0 sites sampled.

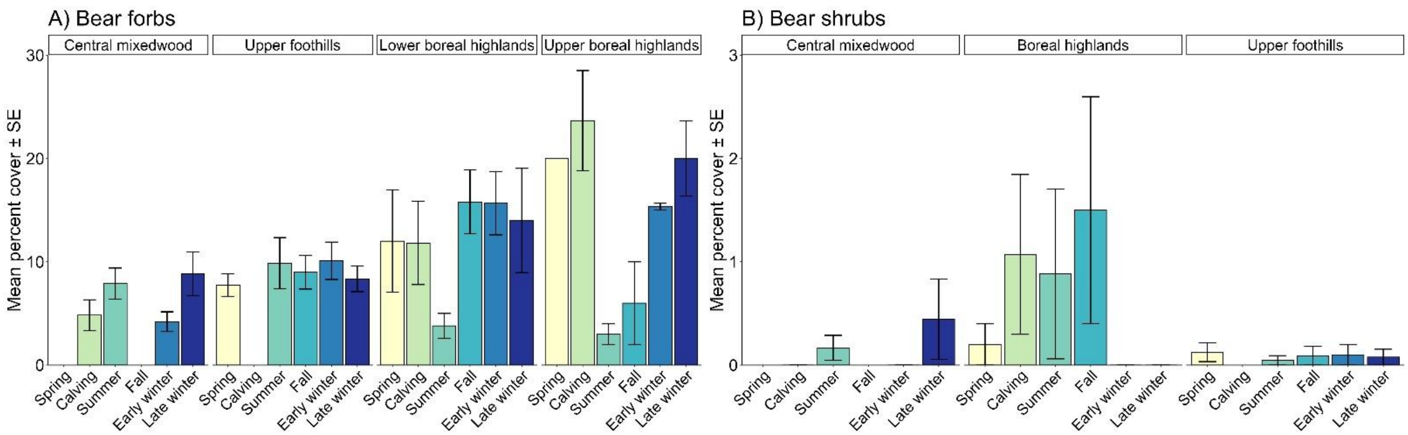

Figure A5. Mean values of forage groups A) Caribou forbs, and B) Caribou lichens compared between seasons (caribou use) across natural subregions. Error bars represent standard error (SE) of the mean. Data includes caribou use sites only. Some missing columns (e.g., 'spring' and 'fall' in Central Mixedwood, 'calving' in Upper Foothills) represent 0 sites sampled. Bear shrubs were not observed in caribou use sites in the Upper Boreal Highlands, so values reflect sites in Lower Boreal Highlands.

Supporting tables (Section 3.3.1)

Table A6. The effects of strata (disturbance type and time since disturbance) on ***basal area (BA.Alive)****. Reference category is 'Caribou use >40'. 2.5% and 97.5% CI refer to the lower and upper confidence intervals. Significant differences are displayed in bold.*

NSR [a]	Strata category [b]	Estimate	Std. Error	2.5% CI	97.5% CI	t value	*P-value*
CM	Intercept	0.206	0.097	0.014	0.398	2.115	**0.036**
	Cutblock 0–10	-0.998	0.287	-1.564	-0.433	-3.480	**0.001**
	Cutblock 11–20	-0.306	0.214	-0.729	0.116	-1.430	0.154
	Cutblock 21–30	0.882	0.225	0.439	1.325	3.925	**<0.001**
	Cutblock 31–40	1.693	0.345	1.014	2.372	4.913	**<0.001**
	Wildfire 0–10	-0.952	0.171	-1.289	-0.614	-5.555	**<0.001**
	Wildfire 11–20	-0.560	0.189	-0.933	-0.188	-2.965	**0.003**
	Wildfire 21–30	-0.668	0.198	-1.058	-0.277	-3.369	**0.001**
	Wildfire 31–40	0.270	0.206	-0.135	0.676	1.315	0.190
F	Intercept	0.520	0.077	0.369	0.672	6.748	**<0.001**
	Cutblock 0–10	-1.445	0.161	-1.762	-1.129	-8.984	**<0.001**
	Cutblock 11–20	-1.120	0.163	-1.440	-0.800	-6.883	**<0.001**
	Cutblock 21–30	-0.513	0.157	-0.823	-0.203	-3.261	**0.001**
	Cutblock 31–40	0.058	0.182	-0.300	0.416	0.320	0.749
	Wildfire 0–10	-1.213	0.159	-1.526	-0.900	-7.626	**<0.001**
	Wildfire 11–20	-0.743	0.285	-1.304	-0.182	-2.608	**0.010**
	Wildfire 21–30	-0.171	0.376	-0.912	0.569	-0.455	0.649
	Wildfire 31–40	0.340	0.587	-0.816	1.496	0.579	0.563
LBH	Intercept	0.510	0.116	0.281	0.739	4.401	**<0.001**
	Cutblock 0–10	-1.288	0.263	-1.807	-0.768	-4.894	**<0.001**
	Cutblock 11–20	-0.827	0.255	-1.331	-0.323	-3.237	**0.001**
	Cutblock 21–30	0.022	0.272	-0.514	0.559	0.082	0.935
	Cutblock 31–40	0.360	0.367	-0.364	1.083	0.981	0.328
	Wildfire 0–10	-1.272	0.242	-1.751	-0.793	-5.246	**<0.001**
	Wildfire 11–20	-0.915	0.242	-1.393	-0.436	-3.773	**<0.001**
	Wildfire 21–30	-1.091	0.212	-1.510	-0.672	-5.145	**<0.001**
	Wildfire 31–40	-0.157	0.219	-0.590	0.275	-0.719	0.473
UBH	Intercept	0.863	0.148	0.568	1.159	5.816	**<0.001**
	Cutblock 0–10	-1.721	0.262	-2.243	-1.200	-6.574	**<0.001**
	Cutblock 11–20	-1.341	0.253	-1.845	-0.838	-5.306	**<0.001**
	Cutblock 21–30	-0.599	0.325	-1.246	0.049	-1.841	0.070
	Cutblock 31–40	0.000	0.325	-0.648	0.647	-0.001	0.999
	Wildfire 0–10	-1.699	0.253	-2.203	-1.196	-6.721	**<0.001**
	Wildfire 11–20	-1.694	0.245	-2.182	-1.206	-6.910	**<0.001**
	Wildfire 21–30	-1.312	0.325	-1.960	-0.664	-4.035	**<0.001**
	Wildfire 31–40	0.064	0.245	-0.425	0.552	0.260	0.796

Notes: [a] NSR = natural subregion, CM = Central Mixedwood, F = Foothills, LBH = Lower Boreal Highlands, UBH = Upper Boreal Highlands; [b] numbers displayed in strata category refer to time since disturbance (years).

*Table A7. The effects of strata (disturbance type and time since disturbance) on **deciduous basal area (BA.d.Alive)**. Reference category is 'Caribou use >40'. 2.5% and 97.5% CI refer to the lower and upper confidence intervals. Significant differences are displayed in bold.*

NSR [a]	Strata category [b]	Estimate	Std. Error	2.5% CI	97.5% CI	t value	*P-value*
CM	Intercept	0.093	0.110	-0.124	0.309	0.843	0.400
	Cutblock 0–10	-0.646	0.323	-1.283	-0.008	-1.997	**0.047**
	Cutblock 11–20	-0.066	0.241	-0.542	0.409	-0.275	0.783
	Cutblock 21–30	0.480	0.253	-0.019	0.979	1.897	0.059
	Cutblock 31–40	1.308	0.388	0.543	2.073	3.369	**0.001**
	Wildfire 0–10	-0.615	0.193	-0.995	-0.234	-3.185	**0.002**
	Wildfire 11–20	-0.430	0.213	-0.850	-0.010	-2.019	**0.045**
	Wildfire 21–30	-0.408	0.223	-0.849	0.032	-1.829	0.069
	Wildfire 31–40	0.566	0.232	0.110	1.023	2.444	**0.015**
F	Intercept	-0.123	0.091	-0.302	0.057	-1.348	0.179
	Cutblock 0–10	-0.075	0.190	-0.449	0.299	-0.394	0.694
	Cutblock 11–20	0.023	0.192	-0.355	0.402	0.120	0.905
	Cutblock 21–30	0.203	0.186	-0.163	0.569	1.093	0.276
	Cutblock 31–40	0.991	0.215	0.568	1.414	4.612	**0.000**
	Wildfire 0–10	0.197	0.188	-0.173	0.567	1.046	0.297
	Wildfire 11–20	-0.075	0.337	-0.738	0.588	-0.223	0.824
	Wildfire 21–30	-0.075	0.444	-0.950	0.800	-0.169	0.866
	Wildfire 31–40	-0.075	0.694	-1.441	1.291	-0.108	0.914
LBH	Intercept	0.055	0.127	-0.195	0.305	0.433	0.665
	Cutblock 0–10	-0.500	0.288	-1.068	0.068	-1.737	0.084
	Cutblock 11–20	0.004	0.279	-0.547	0.556	0.015	0.988
	Cutblock 21–30	0.670	0.297	0.083	1.257	2.254	**0.025**
	Cutblock 31–40	1.560	0.401	0.769	2.352	3.892	**0.000**
	Wildfire 0–10	-0.500	0.265	-1.023	0.024	-1.885	0.061
	Wildfire 11–20	-0.242	0.265	-0.765	0.282	-0.912	0.363
	Wildfire 21–30	-0.305	0.232	-0.763	0.153	-1.315	0.190
	Wildfire 31–40	-0.081	0.240	-0.554	0.392	-0.337	0.737
UBH	Intercept	-0.035	0.213	-0.459	0.389	-0.165	0.870
	Cutblock 0–10	-0.276	0.376	-1.024	0.472	-0.734	0.465
	Cutblock 11–20	0.062	0.363	-0.660	0.784	0.172	0.864
	Cutblock 21–30	1.773	0.466	0.844	2.702	3.801	**0.000**
	Cutblock 31–40	-0.214	0.466	-1.143	0.715	-0.459	0.648
	Wildfire 0–10	-0.276	0.363	-0.998	0.446	-0.761	0.449
	Wildfire 11–20	-0.151	0.352	-0.851	0.550	-0.428	0.670
	Wildfire 21–30	-0.246	0.466	-1.175	0.684	-0.526	0.600
	Wildfire 31–40	0.244	0.352	-0.456	0.944	0.694	0.490

Notes: [a] NSR = natural subregion, CM = Central Mixedwood, F = Foothills, LBH = Lower Boreal Highlands, UBH = Upper Boreal Highlands; [b] numbers displayed in strata category refer to time since disturbance (years).

Table A8. The effects of strata (disturbance type and time since disturbance) on ***quadratic mean diameter (QMD)****. Reference category is 'Caribou use >40'. 2.5% and 97.5% CI refer to the lower and upper confidence intervals. Significant differences are displayed in bold.*

NSR [a]	Strata category [b]	Estimate	Std. Error	2.5% CI	97.5% CI	t value	*P-value*
CM	Intercept	0.497	0.090	0.319	0.674	5.522	**<0.001**
	Cutblock 0–10	-1.590	0.265	-2.112	-1.068	-6.005	**<0.001**
	Cutblock 11–20	-0.526	0.198	-0.916	-0.137	-2.662	**0.008**
	Cutblock 21–30	0.381	0.207	-0.027	0.790	1.840	0.067
	Cutblock 31–40	0.716	0.318	0.089	1.342	2.250	**0.025**
	Wildfire 0–10	-1.549	0.158	-1.861	-1.238	-9.798	**<0.001**
	Wildfire 11–20	-1.092	0.174	-1.436	-0.749	-6.263	**<0.001**
	Wildfire 21–30	-0.736	0.183	-1.096	-0.375	-4.023	**<0.001**
	Wildfire 31–40	-0.013	0.190	-0.387	0.361	-0.066	0.947
F	Intercept	0.522	0.075	0.374	0.669	6.971	**<0.001**
	Cutblock 0–10	-1.737	0.156	-2.044	-1.429	-11.125	**<0.001**
	Cutblock 11–20	-0.803	0.158	-1.114	-0.493	-5.087	**<0.001**
	Cutblock 21–30	-0.348	0.153	-0.648	-0.047	-2.276	**0.024**
	Cutblock 31–40	-0.206	0.176	-0.553	0.142	-1.165	0.245
	Wildfire 0–10	-1.307	0.154	-1.611	-1.003	-8.467	**<0.001**
	Wildfire 11–20	-0.174	0.277	-0.718	0.371	-0.629	0.530
	Wildfire 21–30	-0.477	0.365	-1.195	0.242	-1.306	0.193
	Wildfire 31–40	0.045	0.570	-1.077	1.166	0.078	0.938
LBH	Intercept	0.646	0.107	0.434	0.858	6.025	**<0.001**
	Cutblock 0–10	-1.916	0.243	-2.397	-1.436	-7.872	**<0.001**
	Cutblock 11–20	-0.659	0.236	-1.126	-0.192	-2.789	**0.006**
	Cutblock 21–30	-0.244	0.251	-0.741	0.252	-0.971	0.333
	Cutblock 31–40	0.062	0.339	-0.607	0.732	0.183	0.855
	Wildfire 0–10	-1.534	0.224	-1.976	-1.091	-6.838	**<0.001**
	Wildfire 11–20	-1.088	0.224	-1.531	-0.645	-4.852	**<0.001**
	Wildfire 21–30	-1.133	0.196	-1.520	-0.745	-5.774	**<0.001**
	Wildfire 31–40	-0.398	0.203	-0.798	0.002	-1.963	0.051
UBH	Intercept	0.866	0.141	0.585	1.146	6.144	**<0.001**
	Cutblock 0–10	-2.019	0.249	-2.514	-1.524	-8.121	**<0.001**
	Cutblock 11–20	-0.820	0.240	-1.298	-0.342	-3.416	**0.001**
	Cutblock 21–30	-0.415	0.309	-1.030	0.200	-1.344	0.183
	Cutblock 31–40	-0.103	0.309	-0.718	0.512	-0.333	0.740
	Wildfire 0–10	-1.729	0.240	-2.207	-1.251	-7.205	**<0.001**
	Wildfire 11–20	-1.855	0.233	-2.318	-1.391	-7.969	**<0.001**
	Wildfire 21–30	-1.174	0.309	-1.789	-0.559	-3.802	**<0.001**
	Wildfire 31–40	-0.098	0.233	-0.561	0.366	-0.420	0.675

Notes: [a] NSR = natural subregion, CM = Central Mixedwood, F = Foothills, LBH = Lower Boreal Highlands, UBH = Upper Boreal Highlands; [b] numbers displayed in strata category refer to time since disturbance (years).

*Table A9. The effects of strata (disturbance type and time since disturbance) on **stems per hectare (SPH)**. Reference category is 'Caribou use >40'. 2.5% and 97.5% CI refer to the lower and upper confidence intervals. Significant differences are displayed in bold.*

NSR [a]	Strata category [b]	Estimate	Std. Error	2.5% CI	97.5% CI	t value	*P-value*
CM	Intercept	0.179	0.104	-0.025	0.384	1.727	0.086
	Cutblock 0–10	-1.020	0.306	-1.622	-0.417	-3.337	**0.001**
	Cutblock 11–20	0.217	0.228	-0.233	0.667	0.952	0.342
	Cutblock 21–30	0.645	0.239	0.173	1.117	2.696	**0.008**
	Cutblock 31–40	0.776	0.367	0.053	1.500	2.115	**0.036**
	Wildfire 0–10	-1.024	0.183	-1.384	-0.664	-5.610	**<0.001**
	Wildfire 11–20	-0.393	0.201	-0.790	0.004	-1.953	0.052
	Wildfire 21–30	-0.565	0.211	-0.981	-0.148	-2.674	**0.008**
	Wildfire 31–40	0.362	0.219	-0.070	0.794	1.652	0.100
F	Intercept	0.336	0.076	0.187	0.485	4.439	**<0.001**
	Cutblock 0–10	-1.298	0.158	-1.609	-0.987	-8.210	**<0.001**
	Cutblock 11–20	-0.589	0.160	-0.903	-0.274	-3.681	**<0.001**
	Cutblock 21–30	0.053	0.155	-0.252	0.357	0.342	0.733
	Cutblock 31–40	0.319	0.179	-0.032	0.671	1.788	0.075
	Wildfire 0–10	-1.253	0.156	-1.560	-0.945	-8.012	**<0.001**
	Wildfire 11–20	-0.824	0.280	-1.376	-0.273	-2.943	**0.004**
	Wildfire 21–30	1.161	0.370	0.433	1.888	3.140	**0.002**
	Wildfire 31–40	0.286	0.577	-0.850	1.422	0.496	0.620
LBH	Intercept	0.196	0.117	-0.035	0.427	1.673	0.096
	Cutblock 0–10	-1.054	0.266	-1.578	-0.529	-3.965	**<0.001**
	Cutblock 11–20	-0.145	0.258	-0.654	0.364	-0.563	0.574
	Cutblock 21–30	0.833	0.274	0.291	1.375	3.034	**0.003**
	Cutblock 31–40	0.549	0.370	-0.182	1.279	1.483	0.140
	Wildfire 0–10	-1.023	0.245	-1.506	-0.540	-4.179	**<0.001**
	Wildfire 11–20	-0.495	0.245	-0.978	-0.011	-2.020	**0.045**
	Wildfire 21–30	-0.651	0.214	-1.074	-0.229	-3.042	**0.003**
	Wildfire 31–40	0.355	0.221	-0.082	0.791	1.603	0.111
UBH	Intercept	0.560	0.175	0.212	0.908	3.207	**0.002**
	Cutblock 0–10	-1.410	0.308	-2.023	-0.796	-4.577	**<0.001**
	Cutblock 11–20	-0.794	0.297	-1.386	-0.202	-2.669	**0.009**
	Cutblock 21–30	-0.042	0.383	-0.804	0.720	-0.109	0.913
	Cutblock 31–40	0.066	0.383	-0.696	0.828	0.171	0.864
	Wildfire 0–10	-1.406	0.297	-1.998	-0.814	-4.728	**<0.001**
	Wildfire 11–20	-1.335	0.288	-1.909	-0.760	-4.629	**<0.001**
	Wildfire 21–30	-0.525	0.383	-1.287	0.237	-1.373	0.174
	Wildfire 31–40	0.389	0.288	-0.186	0.963	1.348	0.182

Notes: [a] NSR = natural subregion, CM = Central Mixedwood, F = Foothills, LBH = Lower Boreal Highlands, UBH = Upper Boreal Highlands; [b] numbers displayed in strata category refer to time since disturbance (years).

Table A10. The effects of strata (disturbance type and time since disturbance) on ***canopy cover****. Reference category is 'Caribou use >40'. 2.5% and 97.5% CI refer to the lower and upper confidence intervals. Significant differences are displayed in bold.*

NSR [a]	Strata category [b]	Estimate	Std. Error	2.5% CI	97.5% CI	t value	*P-value*
CM	Intercept	-0.203	0.105	-0.409	0.004	-1.937	0.054
	Cutblock 0–10	-0.357	0.308	-0.964	0.251	-1.157	0.248
	Cutblock 11–20	0.961	0.230	0.507	1.415	4.175	**<0.001**
	Cutblock 21–30	1.276	0.241	0.800	1.751	5.286	**<0.001**
	Cutblock 31–40	1.431	0.370	0.702	2.161	3.867	**<0.001**
	Wildfire 0–10	-0.345	0.184	-0.707	0.018	-1.872	0.063
	Wildfire 11–20	-0.114	0.203	-0.514	0.286	-0.563	0.574
	Wildfire 21–30	0.162	0.213	-0.258	0.582	0.761	0.448
	Wildfire 31–40	0.590	0.221	0.155	1.026	2.672	**0.008**
F	Intercept	0.220	0.078	0.067	0.373	2.826	**0.005**
	Cutblock 0–10	-1.474	0.162	-1.793	-1.154	-9.077	**<0.001**
	Cutblock 11–20	-0.545	0.164	-0.868	-0.221	-3.316	**0.001**
	Cutblock 21–30	0.324	0.159	0.011	0.636	2.038	**0.042**
	Cutblock 31–40	0.596	0.183	0.235	0.957	3.247	**0.001**
	Wildfire 0–10	-0.524	0.161	-0.840	-0.208	-3.261	**0.001**
	Wildfire 11–20	-0.625	0.288	-1.191	-0.059	-2.173	**0.031**
	Wildfire 21–30	0.332	0.380	-0.415	1.079	0.874	0.383
	Wildfire 31–40	-0.310	0.593	-1.477	0.856	-0.524	0.601
LBH	Intercept	0.075	0.116	-0.153	0.303	0.648	0.518
	Cutblock 0–10	-1.097	0.262	-1.615	-0.579	-4.181	**<0.001**
	Cutblock 11–20	0.014	0.255	-0.488	0.517	0.057	0.955
	Cutblock 21–30	1.095	0.271	0.560	1.630	4.040	**<0.001**
	Cutblock 31–40	1.197	0.365	0.476	1.919	3.277	**0.001**
	Wildfire 0–10	-0.735	0.242	-1.213	-0.258	-3.043	**0.003**
	Wildfire 11–20	-0.373	0.242	-0.850	0.105	-1.542	0.125
	Wildfire 21–30	-0.383	0.211	-0.800	0.034	-1.812	0.072
	Wildfire 31–40	0.341	0.218	-0.090	0.772	1.562	0.120
UBH	Intercept	0.346	0.160	0.027	0.666	2.160	**0.034**
	Cutblock 0–10	-1.631	0.283	-2.194	-1.068	-5.768	**<0.001**
	Cutblock 11–20	-0.477	0.273	-1.021	0.067	-1.747	0.085
	Cutblock 21–30	0.418	0.351	-0.281	1.118	1.191	0.237
	Cutblock 31–40	0.912	0.351	0.213	1.612	2.597	**0.011**
	Wildfire 0–10	-1.066	0.273	-1.610	-0.523	-3.906	**<0.001**
	Wildfire 11–20	-0.946	0.265	-1.473	-0.419	-3.573	**0.001**
	Wildfire 21–30	-0.405	0.351	-1.104	0.295	-1.153	0.253
	Wildfire 31–40	0.587	0.265	0.060	1.114	2.217	**0.030**

Notes: [a] NSR = natural subregion, CM = Central Mixedwood, F = Foothills, LBH = Lower Boreal Highlands, UBH = Upper Boreal Highlands; [b] numbers displayed in strata category refer to time since disturbance (years).

*Table A11. The effects of strata (disturbance type and time since disturbance) on **coniferous saplings**. Reference category is 'Caribou use >40'. 2.5% and 97.5% CI refer to the lower and upper confidence intervals. Significant differences are displayed in bold.*

NSR [a]	Strata category [b]	Estimate	Std. Error	2.5% CI	97.5% CI	t value	*P-value*
CM	Intercept	-0.291	0.111	-0.510	-0.073	-2.626	**0.009**
	Cutblock 0–10	-0.195	0.327	-0.838	0.449	-0.596	0.552
	Cutblock 11–20	-0.181	0.244	-0.662	0.300	-0.743	0.459
	Cutblock 21–30	-0.113	0.256	-0.617	0.391	-0.442	0.659
	Cutblock 31–40	-0.085	0.392	-0.858	0.688	-0.217	0.829
	Wildfire 0–10	0.989	0.195	0.605	1.374	5.072	**<0.001**
	Wildfire 11–20	0.826	0.215	0.402	1.250	3.838	**<0.001**
	Wildfire 21–30	0.489	0.226	0.044	0.933	2.166	**0.031**
	Wildfire 31–40	0.340	0.234	-0.121	0.801	1.453	0.148
F	Intercept	-0.124	0.089	-0.298	0.051	-1.395	0.164
	Cutblock 0–10	0.052	0.185	-0.312	0.417	0.283	0.777
	Cutblock 11–20	0.049	0.187	-0.319	0.418	0.263	0.793
	Cutblock 21–30	-0.091	0.181	-0.448	0.265	-0.504	0.615
	Cutblock 31–40	-0.094	0.209	-0.506	0.318	-0.449	0.654
	Wildfire 0–10	1.083	0.183	0.722	1.443	5.915	**<0.001**
	Wildfire 11–20	0.079	0.328	-0.567	0.724	0.240	0.810
	Wildfire 21–30	-0.032	0.433	-0.884	0.820	-0.074	0.941
	Wildfire 31–40	0.015	0.675	-1.314	1.345	0.023	0.982
LBH	Intercept	-0.199	0.126	-0.447	0.050	-1.579	0.116
	Cutblock 0–10	-0.507	0.285	-1.071	0.056	-1.778	0.077
	Cutblock 11–20	-0.370	0.277	-0.917	0.177	-1.336	0.183
	Cutblock 21–30	0.215	0.295	-0.367	0.797	0.728	0.467
	Cutblock 31–40	-0.327	0.398	-1.112	0.458	-0.822	0.412
	Wildfire 0–10	0.678	0.263	0.159	1.197	2.578	**0.011**
	Wildfire 11–20	0.189	0.263	-0.330	0.708	0.718	0.474
	Wildfire 21–30	0.907	0.230	0.453	1.361	3.942	**<0.001**
	Wildfire 31–40	0.532	0.238	0.063	1.002	2.241	**0.026**
UBH	Intercept	-0.216	0.189	-0.593	0.160	-1.145	0.256
	Cutblock 0–10	0.006	0.334	-0.659	0.670	0.017	0.987
	Cutblock 11–20	-0.367	0.322	-1.008	0.274	-1.140	0.258
	Cutblock 21–30	-0.179	0.414	-1.004	0.646	-0.431	0.668
	Cutblock 31–40	-0.309	0.414	-1.135	0.516	-0.747	0.457
	Wildfire 0–10	0.908	0.322	0.267	1.550	2.821	**0.006**
	Wildfire 11–20	0.330	0.312	-0.292	0.952	1.056	0.294
	Wildfire 21–30	2.231	0.414	1.406	3.056	5.386	**<0.001**
	Wildfire 31–40	0.054	0.312	-0.568	0.676	0.172	0.864

Notes: [a] NSR = natural subregion, CM = Central Mixedwood, F = Foothills, LBH = Lower Boreal Highlands, UBH = Upper Boreal Highlands; [b] numbers displayed in strata category refer to time since disturbance (years).

*Table A12. The effects of strata (disturbance type and time since disturbance) on **coarse woody debris (CWD)**. Reference category is 'Caribou use >40'. 2.5% and 97.5% CI refer to the lower and upper confidence intervals. Significant differences are displayed in bold.*

NSR [a]	Strata category [b]	Estimate	Std. Error	2.5% CI	97.5% CI	t value	*P-value*
CM	Intercept	1.379	0.144	1.104	1.671	9.552	**<0.001**
	Cutblock 0–10	-0.080	0.428	-0.871	0.827	-0.186	0.852
	Cutblock 11–20	-0.244	0.323	-0.859	0.417	-0.755	0.451
	Cutblock 21–30	-0.181	0.337	-0.820	0.512	-0.537	0.591
	Cutblock 31–40	-0.338	0.527	-1.307	0.800	-0.641	0.522
	Wildfire 0–10	1.521	0.242	1.057	2.008	6.293	**<0.001**
	Wildfire 11–20	1.008	0.268	0.497	1.554	3.757	**<0.001**
	Wildfire 21–30	0.700	0.284	0.162	1.280	2.470	**0.014**
	Wildfire 31–40	-0.044	0.305	-0.625	0.579	-0.144	0.885
F	Intercept	2.175	0.079	2.023	2.331	27.689	**<0.001**
	Cutblock 0–10	0.036	0.163	-0.279	0.363	0.218	0.827
	Cutblock 11–20	-0.373	0.170	-0.701	-0.032	-2.188	**0.029**
	Cutblock 21–30	-0.824	0.172	-1.158	-0.481	-4.776	**<0.001**
	Cutblock 31–40	-0.606	0.195	-0.981	-0.215	-3.105	**0.002**
	Wildfire 0–10	1.029	0.155	0.731	1.341	6.621	**<0.001**
	Wildfire 11–20	0.480	0.282	-0.042	1.071	1.704	0.088
	Wildfire 21–30	-1.992	0.539	-3.104	-0.943	-3.695	**<0.001**
	Wildfire 31–40	-0.229	0.610	-1.318	1.152	-0.375	0.708
LBH	Intercept	1.760	0.163	1.453	2.094	10.782	**<0.001**
	Cutblock 0–10	0.428	0.364	-0.250	1.193	1.175	0.240
	Cutblock 11–20	-0.030	0.360	-0.705	0.720	-0.083	0.934
	Cutblock 21–30	-0.662	0.400	-1.414	0.171	-1.654	0.098
	Cutblock 31–40	-0.118	0.520	-1.054	1.028	-0.227	0.820
	Wildfire 0–10	1.596	0.329	0.981	2.280	4.855	**<0.001**
	Wildfire 11–20	1.008	0.331	0.387	1.697	3.043	**0.002**
	Wildfire 21–30	0.703	0.292	0.145	1.298	2.403	**0.016**
	Wildfire 31–40	0.212	0.306	-0.370	0.837	0.694	0.488
UBH	Intercept	1.826	0.168	1.503	2.164	10.845	**<0.001**
	Cutblock 0–10	0.498	0.285	-0.052	1.069	1.749	0.080
	Cutblock 11–20	-0.300	0.296	-0.878	0.287	-1.013	0.311
	Cutblock 21–30	-1.826	0.551	-3.004	-0.799	-3.313	**0.001**
	Cutblock 31–40	0.414	0.354	-0.258	1.138	1.171	0.241
	Wildfire 0–10	1.670	0.263	1.163	2.198	6.351	**<0.001**
	Wildfire 11–20	1.920	0.255	1.428	2.429	7.540	**<0.001**
	Wildfire 21–30	0.855	0.343	0.207	1.560	2.492	**0.013**
	Wildfire 31–40	0.439	0.269	-0.082	0.974	1.636	0.102

Notes: [a] NSR = natural subregion, CM = Central Mixedwood, F = Foothills, LBH = Lower Boreal Highlands, UBH = Upper Boreal Highlands; [b] numbers displayed in strata category refer to time since disturbance (years).

*Table A13**.** The effects of strata (disturbance type and time since disturbance) on **soil depth**. Reference category is 'Caribou use >40'. 2.5% and 97.5% CI refer to the lower and upper confidence intervals. Significant differences are displayed in bold.*

NSR [a]	Strata category [b]	Estimate	Std. Error	2.5% CI	97.5% CI	t value	*P-value*
CM	Intercept	0.596	0.104	0.390	0.801	5.708	**<0.001**
	Cutblock 0–10	-1.002	0.307	-1.607	-0.396	-3.261	**0.001**
	Cutblock 11–20	-1.456	0.229	-1.908	-1.004	-6.347	**<0.001**
	Cutblock 21–30	-1.425	0.241	-1.899	-0.950	-5.923	**<0.001**
	Cutblock 31–40	-1.709	0.369	-2.436	-0.982	-4.632	**<0.001**
	Wildfire 0–10	-0.530	0.183	-0.891	-0.168	-2.887	**0.004**
	Wildfire 11–20	-0.854	0.202	-1.253	-0.455	-4.219	**<0.001**
	Wildfire 21–30	-0.623	0.212	-1.042	-0.205	-2.936	**0.004**
	Wildfire 31–40	-0.452	0.220	-0.886	-0.018	-2.053	**0.041**
F	Intercept	0.398	0.089	0.223	0.573	4.479	**<0.001**
	Cutblock 0–10	-0.829	0.186	-1.194	-0.463	-4.466	**<0.001**
	Cutblock 11–20	-0.711	0.188	-1.081	-0.342	-3.788	**<0.001**
	Cutblock 21–30	-0.655	0.182	-1.013	-0.298	-3.609	**<0.001**
	Cutblock 31–40	-0.820	0.210	-1.233	-0.407	-3.910	**<0.001**
	Wildfire 0–10	-0.516	0.184	-0.877	-0.155	-2.813	**0.005**
	Wildfire 11–20	-0.174	0.329	-0.822	0.473	-0.530	0.596
	Wildfire 21–30	-0.079	0.434	-0.933	0.775	-0.183	0.855
	Wildfire 31–40	-0.475	0.677	-1.808	0.858	-0.701	0.484
LBH	Intercept	0.312	0.127	0.061	0.563	2.457	**0.015**
	Cutblock 0–10	-0.977	0.288	-1.546	-0.408	-3.391	**0.001**
	Cutblock 11–20	-0.885	0.280	-1.437	-0.332	-3.162	**0.002**
	Cutblock 21–30	-0.729	0.298	-1.317	-0.141	-2.450	**0.015**
	Cutblock 31–40	-0.554	0.401	-1.346	0.239	-1.380	0.170
	Wildfire 0–10	-0.618	0.266	-1.142	-0.093	-2.326	**0.021**
	Wildfire 11–20	-0.592	0.266	-1.116	-0.067	-2.228	**0.027**
	Wildfire 21–30	0.301	0.232	-0.158	0.760	1.296	0.197
	Wildfire 31–40	-0.238	0.240	-0.712	0.236	-0.992	0.323
UBH	Intercept	0.306	0.210	-0.112	0.725	1.457	0.149
	Cutblock 0–10	-0.676	0.371	-1.415	0.062	-1.824	0.072
	Cutblock 11–20	-0.529	0.358	-1.242	0.184	-1.477	0.144
	Cutblock 21–30	0.252	0.461	-0.666	1.169	0.547	0.586
	Cutblock 31–40	-0.378	0.461	-1.295	0.540	-0.820	0.415
	Wildfire 0–10	-0.699	0.358	-1.412	0.014	-1.953	0.055
	Wildfire 11–20	-0.960	0.347	-1.651	-0.268	-2.764	**0.007**
	Wildfire 21–30	-0.560	0.461	-1.477	0.358	-1.215	0.228
	Wildfire 31–40	0.575	0.347	-0.117	1.266	1.655	0.102

Notes: [a] NSR = natural subregion, CM = Central Mixedwood, F = Foothills, LBH = Lower Boreal Highlands, UBH = Upper Boreal Highlands; [b] numbers displayed in strata category refer to time since disturbance (years).

*Table A14. The effects of strata (disturbance type and time since disturbance) on **caribou forbs**. Reference category is 'Caribou use >40'. 2.5% and 97.5% CI refer to the lower and upper confidence intervals. Significant differences are displayed in bold.*

NSR [a]	Strata category [b]	Estimate	Std. Error	2.5% CI	97.5% CI	t value	*P-value*
CM	Intercept	0.610	0.226	0.187	1.079	2.694	**0.007**
	Cutblock 0–10	0.525	0.648	-0.617	2.009	0.810	0.418
	Cutblock 11–20	-0.168	0.503	-1.106	0.898	-0.334	0.738
	Cutblock 21–30	0.083	0.519	-0.874	1.198	0.160	0.873
	Cutblock 31–40	0.594	0.775	-0.728	2.468	0.767	0.443
	Wildfire 0–10	-0.215	0.403	-0.987	0.606	-0.533	0.594
	Wildfire 11–20	0.515	0.429	-0.292	1.410	1.200	0.230
	Wildfire 21–30	0.342	0.453	-0.505	1.293	0.755	0.450
	Wildfire 31–40	-2.507	0.731	-4.104	-1.139	-3.430	**0.001**
F	Intercept	1.741	0.125	1.504	1.994	13.943	**<0.001**
	Cutblock 0–10	0.175	0.259	-0.315	0.704	0.677	0.498
	Cutblock 11–20	0.081	0.263	-0.417	0.618	0.308	0.758
	Cutblock 21–30	0.065	0.254	-0.418	0.583	0.255	0.799
	Cutblock 31–40	0.402	0.290	-0.142	1.004	1.383	0.167
	Wildfire 0–10	-0.154	0.259	-0.647	0.374	-0.596	0.551
	Wildfire 11–20	0.595	0.452	-0.208	1.597	1.316	0.188
	Wildfire 21–30	0.146	0.605	-0.897	1.556	0.242	0.809
	Wildfire 31–40	0.051	0.949	-1.483	2.558	0.054	0.957
LBH	Intercept	1.349	0.220	0.941	1.806	6.143	**<0.001**
	Cutblock 0–10	-0.200	0.503	-1.125	0.882	-0.398	0.691
	Cutblock 11–20	-0.203	0.488	-1.105	0.840	-0.417	0.677
	Cutblock 21–30	0.484	0.507	-0.437	1.590	0.955	0.339
	Cutblock 31–40	-1.754	0.830	-3.368	0.037	-2.114	**0.035**
	Wildfire 0–10	0.454	0.453	-0.385	1.417	1.002	0.316
	Wildfire 11–20	1.249	0.446	0.425	2.202	2.799	**0.005**
	Wildfire 21–30	-0.194	0.405	-0.962	0.641	-0.478	0.632
	Wildfire 31–40	-0.543	0.425	-1.349	0.337	-1.276	0.202
UBH	Intercept	2.060	0.313	1.495	2.733	6.582	**<0.001**
	Cutblock 0–10	-2.060	0.634	-3.295	-0.767	-3.250	**0.001**
	Cutblock 11–20	-0.533	0.541	-1.566	0.595	-0.986	0.324
	Cutblock 21–30	-2.976	0.972	-5.092	-1.063	-3.062	**0.002**
	Cutblock 31–40	-0.268	0.691	-1.515	1.292	-0.387	0.699
	Wildfire 0–10	0.707	0.527	-0.295	1.812	1.342	0.180
	Wildfire 11–20	0.009	0.517	-0.982	1.080	0.016	0.987
	Wildfire 21–30	-0.779	0.707	-2.066	0.803	-1.101	0.271
	Wildfire 31–40	-0.268	0.520	-1.266	0.810	-0.515	0.607

Notes: [a] NSR = natural subregion, CM = Central Mixedwood, F = Foothills, LBH = Lower Boreal Highlands, UBH = Upper Boreal Highlands; [b] numbers displayed in strata category refer to time since disturbance (years).

Table A15. The effects of strata (disturbance type and time since disturbance) on ***caribou lichens****. Reference category is 'Caribou use >40'. 2.5% and 97.5% CI refer to the lower and upper confidence intervals. Significant differences are displayed in bold.*

NSR [a]	Strata category [b]	Estimate	Std. Error	2.5% CI	97.5% CI	t value	*P-value*
CM	Intercept	1.534	0.201	1.161	1.952	7.636	**<0.001**
	Cutblock 0–10	-2.345	0.759	-3.868	-0.780	-3.090	**0.002**
	Cutblock 11–20	-1.786	0.505	-2.752	-0.746	-3.539	**<0.001**
	Cutblock 21–30	-1.416	0.507	-2.370	-0.353	-2.796	**0.005**
	Cutblock 31–40	-2.633	0.984	-4.747	-0.617	-2.675	**0.007**
	Wildfire 0–10	-1.853	0.400	-2.630	-1.051	-4.633	**<0.001**
	Wildfire 11–20	0.341	0.386	-0.385	1.146	0.882	0.378
	Wildfire 21–30	0.195	0.407	-0.563	1.050	0.480	0.631
	Wildfire 31–40	-0.892	0.442	-1.721	0.033	-2.020	**0.043**
F	Intercept	1.309	0.130	1.062	1.571	10.095	**<0.001**
	Cutblock 0–10	-1.657	0.327	-2.299	-1.010	-5.069	**<0.001**
	Cutblock 11–20	-0.200	0.277	-0.727	0.364	-0.723	0.470
	Cutblock 21–30	-0.287	0.269	-0.801	0.259	-1.066	0.286
	Cutblock 31–40	-0.539	0.318	-1.142	0.113	-1.694	0.090
	Wildfire 0–10	-1.645	0.322	-2.277	-1.008	-5.106	**<0.001**
	Wildfire 11–20	-0.415	0.495	-1.320	0.658	-0.838	0.402
	Wildfire 21–30	-1.532	0.772	-3.061	0.101	-1.984	**0.047**
	Wildfire 31–40	-0.393	1.020	-2.147	2.219	-0.385	0.700
LBH	Intercept	2.834	0.168	2.520	3.182	16.846	**<0.001**
	Cutblock 0–10	-2.308	0.432	-3.130	-1.417	-5.340	**<0.001**
	Cutblock 11–20	-2.640	0.438	-3.485	-1.748	-6.023	**<0.001**
	Cutblock 21–30	-1.736	0.423	-2.525	-0.848	-4.107	**<0.001**
	Cutblock 31–40	-1.491	0.563	-2.502	-0.240	-2.648	**0.008**
	Wildfire 0–10	-2.774	0.423	-3.595	-1.921	-6.556	**<0.001**
	Wildfire 11–20	-0.880	0.359	-1.552	-0.130	-2.449	**0.014**
	Wildfire 21–30	-1.134	0.316	-1.737	-0.488	-3.582	**<0.001**
	Wildfire 31–40	-1.472	0.332	-2.105	-0.792	-4.429	**<0.001**
UBH	Intercept	3.442	0.231	3.019	3.930	14.884	**<0.001**
	Cutblock 0–10	-4.030	0.602	-5.289	-2.883	-6.691	**<0.001**
	Cutblock 11–20	-3.666	0.526	-4.730	-2.642	-6.966	**<0.001**
	Cutblock 21–30	-3.666	0.707	-5.128	-2.273	-5.182	**<0.001**
	Cutblock 31–40	-2.855	0.601	-4.012	-1.608	-4.748	**<0.001**
	Wildfire 0–10	-3.347	0.493	-4.326	-2.374	-6.792	**<0.001**
	Wildfire 11–20	-0.935	0.388	-1.680	-0.144	-2.411	**0.016**
	Wildfire 21–30	-0.877	0.516	-1.820	0.243	-1.702	0.089
	Wildfire 31–40	-2.544	0.424	-3.369	-1.691	-5.997	**<0.001**

Notes: [a] NSR = natural subregion, CM = Central Mixedwood, F = Foothills, LBH = Lower Boreal Highlands, UBH = Upper Boreal Highlands; [b] numbers displayed in strata category refer to time since disturbance (years).

*Table A16. The effects of strata (disturbance type and time since disturbance) on **moose forbs**. Reference category is 'Caribou use >40'. 2.5% and 97.5% CI refer to the lower and upper confidence intervals. Significant differences are displayed in bold*

NSR [a]	Strata category [b]	Estimate	Std. Error	2.5% CI	97.5% CI	t value	*P-value*
CM	Intercept	2.462	0.090	2.289	2.642	27.368	**<0.001**
	Cutblock 0–10	0.209	0.261	-0.281	0.749	0.798	0.425
	Cutblock 11–20	-0.176	0.200	-0.559	0.227	-0.879	0.379
	Cutblock 21–30	-0.406	0.214	-0.815	0.025	-1.900	0.057
	Cutblock 31–40	-0.005	0.318	-0.595	0.662	-0.016	0.988
	Wildfire 0–10	0.549	0.155	0.250	0.857	3.551	**<0.001**
	Wildfire 11–20	0.508	0.170	0.180	0.849	2.978	**0.003**
	Wildfire 21–30	0.187	0.181	-0.161	0.551	1.033	0.302
	Wildfire 31–40	-0.216	0.192	-0.585	0.171	-1.121	0.262
F	Intercept	2.127	0.078	1.976	2.282	27.305	**<0.001**
	Cutblock 0–10	0.574	0.158	0.271	0.890	3.637	**<0.001**
	Cutblock 11–20	0.468	0.160	0.161	0.790	2.923	**0.003**
	Cutblock 21–30	0.325	0.156	0.025	0.638	2.085	**0.037**
	Cutblock 31–40	0.438	0.179	0.097	0.800	2.449	**0.014**
	Wildfire 0–10	0.250	0.158	-0.054	0.567	1.581	0.114
	Wildfire 11–20	0.918	0.274	0.412	1.492	3.353	**0.001**
	Wildfire 21–30	0.253	0.373	-0.427	1.052	0.678	0.497
	Wildfire 31–40	0.646	0.569	-0.338	1.960	1.136	0.256
LBH	Intercept	2.753	0.115	2.535	2.984	24.039	**<0.001**
	Cutblock 0–10	0.138	0.259	-0.350	0.669	0.532	0.595
	Cutblock 11–20	0.278	0.250	-0.194	0.791	1.112	0.266
	Cutblock 21–30	-0.409	0.274	-0.925	0.153	-1.497	0.135
	Cutblock 31–40	-0.694	0.377	-1.390	0.102	-1.844	0.065
	Wildfire 0–10	-0.438	0.244	-0.902	0.058	-1.794	0.073
	Wildfire 11–20	-0.028	0.240	-0.484	0.460	-0.117	0.907
	Wildfire 21–30	0.569	0.207	0.172	0.984	2.752	**0.006**
	Wildfire 31–40	0.187	0.215	-0.225	0.621	0.868	0.386
UBH	Intercept	2.105	0.145	1.825	2.396	14.492	**<0.001**
	Cutblock 0–10	0.760	0.242	0.293	1.243	3.143	**0.002**
	Cutblock 11–20	0.967	0.232	0.519	1.429	4.176	**<0.001**
	Cutblock 21–30	-0.077	0.321	-0.696	0.570	-0.240	0.810
	Cutblock 31–40	1.056	0.292	0.502	1.653	3.612	**<0.001**
	Wildfire 0–10	0.751	0.234	0.298	1.218	3.209	**0.001**
	Wildfire 11–20	0.977	0.225	0.541	1.425	4.342	**<0.001**
	Wildfire 21–30	0.460	0.304	-0.120	1.077	1.512	0.130
	Wildfire 31–40	0.051	0.239	-0.414	0.524	0.212	0.832

Notes: [a] NSR = natural subregion, CM = Central Mixedwood, F = Foothills, LBH = Lower Boreal Highlands, UBH = Upper Boreal Highlands; [b] numbers displayed in strata category refer to time since disturbance (years).

Table A17. The effects of strata (disturbance type and time since disturbance) on ***moose saplings****. Reference category is 'Caribou use >40'. 2.5% and 97.5% CI refer to the lower and upper confidence intervals. Significant differences are displayed in bold.*

NSR [a]	Strata category [b]	Estimate	Std. Error	2.5% CI	97.5% CI	t value	*P-value*
CM	Intercept	0.330	0.243	-0.123	0.833	1.361	0.173
	Cutblock 0–10	4.401	0.657	3.272	5.949	6.702	**<0.001**
	Cutblock 11–20	3.878	0.495	2.974	4.954	7.828	**<0.001**
	Cutblock 21–30	2.729	0.520	1.787	3.872	5.245	**<0.001**
	Cutblock 31–40	1.728	0.798	0.398	3.713	2.165	**0.030**
	Wildfire 0–10	3.870	0.401	3.108	4.697	9.657	**<0.001**
	Wildfire 11–20	2.957	0.441	2.134	3.885	6.712	**<0.001**
	Wildfire 21–30	2.703	0.462	1.848	3.687	5.858	**<0.001**
	Wildfire 31–40	1.347	0.485	0.451	2.385	2.776	**0.005**
F	Intercept	-0.711	0.218	-1.133	-0.273	-3.255	**0.001**
	Cutblock 0–10	3.665	0.386	2.941	4.470	9.486	**<0.001**
	Cutblock 11–20	4.001	0.390	3.273	4.815	10.267	**<0.001**
	Cutblock 21–30	3.956	0.378	3.246	4.742	10.453	**<0.001**
	Cutblock 31–40	3.361	0.432	2.567	4.282	7.783	**<0.001**
	Wildfire 0–10	4.954	0.381	4.240	5.747	12.998	**<0.001**
	Wildfire 11–20	2.818	0.663	1.684	4.383	4.253	**<0.001**
	Wildfire 21–30	2.469	0.873	1.048	4.717	2.828	**0.005**
	Wildfire 31–40	2.097	1.369	0.049	6.398	1.532	0.125
LBH	Intercept	0.909	0.310	0.348	1.575	2.930	**0.003**
	Cutblock 0–10	3.116	0.683	1.907	4.693	4.564	**<0.001**
	Cutblock 11–20	2.436	0.664	1.250	3.953	3.668	**<0.001**
	Cutblock 21–30	2.856	0.705	1.617	4.504	4.049	**<0.001**
	Cutblock 31–40	1.754	0.952	0.206	4.262	1.842	0.066
	Wildfire 0–10	3.674	0.630	2.535	5.086	5.834	**<0.001**
	Wildfire 11–20	2.349	0.631	1.208	3.764	3.723	**<0.001**
	Wildfire 21–30	1.583	0.555	0.545	2.774	2.852	**0.004**
	Wildfire 31–40	0.611	0.579	-0.464	1.861	1.056	0.291
UBH	Intercept	0.274	0.374	-0.428	1.054	0.735	0.463
	Cutblock 0–10	1.313	0.610	0.157	2.595	2.150	**0.032**
	Cutblock 11–20	1.912	0.583	0.801	3.128	3.278	**0.001**
	Cutblock 21–30	3.269	0.724	1.970	4.916	4.517	**<0.001**
	Cutblock 31–40	1.671	0.739	0.336	3.340	2.261	**0.024**
	Wildfire 0–10	4.108	0.575	3.015	5.310	7.150	**<0.001**
	Wildfire 11–20	3.627	0.560	2.555	4.787	6.478	**<0.001**
	Wildfire 21–30	3.968	0.722	2.674	5.612	5.498	**<0.001**
	Wildfire 31–40	1.532	0.571	0.437	2.713	2.682	**0.007**

Notes: [a] NSR = natural subregion, CM = Central Mixedwood, F = Foothills, LBH = Lower Boreal Highlands, UBH = Upper Boreal Highlands; [b] numbers displayed in strata category refer to time since disturbance (years).

*Table A18. The effects of strata (disturbance type and time since disturbance) on **moose shrubs**. Reference category is 'Caribou use >40'. 2.5% and 97.5% CI refer to the lower and upper confidence intervals. Significant differences are displayed in bold.*

NSR [a]	Strata category [b]	Estimate	Std. Error	2.5% CI	97.5% CI	t value	*P-value*
CM	Intercept	0.890	0.153	0.597	1.197	5.827	**<0.001**
	Cutblock 0–10	0.742	0.422	-0.034	1.642	1.757	0.079
	Cutblock 11–20	1.753	0.306	1.177	2.386	5.723	**<0.001**
	Cutblock 21–30	0.780	0.332	0.156	1.465	2.353	**0.019**
	Cutblock 31–40	1.361	0.490	0.488	2.450	2.776	**0.006**
	Wildfire 0–10	1.382	0.251	0.900	1.885	5.517	**<0.001**
	Wildfire 11–20	0.140	0.292	-0.422	0.729	0.478	0.633
	Wildfire 21–30	1.665	0.285	1.124	2.248	5.837	**<0.001**
	Wildfire 31–40	1.285	0.298	0.721	1.897	4.309	**<0.001**
F	Intercept	-0.729	0.187	-1.096	-0.363	-3.908	**<0.001**
	Cutblock 0–10	0.758	0.345	0.092	1.450	2.197	**0.028**
	Cutblock 11–20	2.570	0.311	1.979	3.205	8.253	**<0.001**
	Cutblock 21–30	2.553	0.303	1.976	3.168	8.422	**<0.001**
	Cutblock 31–40	1.904	0.351	1.243	2.625	5.433	**<0.001**
	Wildfire 0–10	2.703	0.305	2.124	3.323	8.871	**<0.001**
	Wildfire 11–20	1.576	0.541	0.589	2.753	2.913	**0.004**
	Wildfire 21–30	0.729	0.783	-0.759	2.447	0.931	0.352
LBH	Intercept	0.773	0.238	0.329	1.269	3.243	**0.001**
	Cutblock 0–10	-0.006	0.542	-1.005	1.159	-0.011	0.991
	Cutblock 11–20	0.747	0.509	-0.187	1.845	1.468	0.142
	Cutblock 21–30	1.275	0.534	0.308	2.448	2.387	**0.017**
	Cutblock 31–40	1.264	0.716	0.039	2.976	1.764	0.078
	Wildfire 0–10	0.549	0.486	-0.353	1.584	1.128	0.259
	Wildfire 11–20	-0.550	0.520	-1.530	0.537	-1.059	0.290
	Wildfire 21–30	0.569	0.426	-0.239	1.451	1.334	0.182
	Wildfire 31–40	0.402	0.442	-0.433	1.323	0.908	0.364
UBH	Intercept	-0.054	0.356	-0.748	0.660	-0.152	0.879
	Cutblock 0–10	-0.197	0.647	-1.481	1.088	-0.305	0.761
	Cutblock 11–20	2.095	0.523	1.097	3.170	4.003	**<0.001**
	Cutblock 21–30	3.050	0.637	1.888	4.444	4.788	**<0.001**
	Cutblock 31–40	0.054	0.772	-1.461	1.641	0.070	0.944
	Wildfire 0–10	1.759	0.528	0.750	2.842	3.328	**0.001**
	Wildfire 11–20	1.548	0.519	0.553	2.604	2.983	**0.003**
	Wildfire 21–30	0.524	0.722	-0.849	2.041	0.726	0.468
	Wildfire 31–40	1.799	0.514	0.813	2.848	3.497	**<0.001**

Notes: Missing strata category is due to 0 abundance of forage group in respective sites; [a] NSR = natural subregion, CM = Central Mixedwood, F = Foothills, LBH = Lower Boreal Highlands, UBH = Upper Boreal Highlands; [b] numbers displayed in strata category refer to time since disturbance (years); [c] 2.5% CI = lower confidence interval, 97.5% CI = upper confidence interval

*Table A19. The effects of strata (disturbance type and time since disturbance) on **bear forbs**. Reference category is 'Caribou use >40'. 2.5% and 97.5% CI refer to the lower and upper confidence intervals. Significant differences are displayed in bold.*

NSR [a]	Strata category [b]	Estimate	Std. Error	2.5% CI	97.5% CI	t value	*P-value*
CM	Intercept	1.877	0.113	1.661	2.104	16.617	**<0.001**
	Cutblock 0–10	0.216	0.328	-0.394	0.901	0.659	0.510
	Cutblock 11–20	0.560	0.241	0.103	1.051	2.325	**0.020**
	Cutblock 21–30	0.292	0.256	-0.193	0.814	1.141	0.254
	Cutblock 31–40	0.282	0.392	-0.434	1.120	0.721	0.471
	Wildfire 0–10	0.464	0.194	0.089	0.852	2.388	**0.017**
	Wildfire 11–20	0.270	0.216	-0.144	0.704	1.250	0.211
	Wildfire 21–30	0.904	0.221	0.483	1.350	4.097	**<0.001**
	Wildfire 31–40	0.090	0.237	-0.363	0.569	0.379	0.705
F	Intercept	2.191	0.081	2.036	2.352	27.199	**<0.001**
	Cutblock 0–10	0.096	0.167	-0.225	0.432	0.577	0.564
	Cutblock 11–20	-0.018	0.170	-0.345	0.323	-0.106	0.916
	Cutblock 21–30	0.106	0.164	-0.209	0.433	0.646	0.518
	Cutblock 31–40	0.380	0.186	0.025	0.757	2.039	**0.041**
	Wildfire 0–10	0.006	0.166	-0.314	0.339	0.035	0.972
	Wildfire 11–20	0.531	0.289	-0.002	1.139	1.838	0.066
	Wildfire 21–30	-0.543	0.413	-1.309	0.333	-1.314	0.189
	Wildfire 31–40	0.374	0.599	-0.662	1.767	0.623	0.533
LBH	Intercept	2.415	0.140	2.151	2.699	17.301	**<0.001**
	Cutblock 0–10	0.368	0.313	-0.218	1.021	1.173	0.241
	Cutblock 11–20	-0.353	0.312	-0.940	0.291	-1.132	0.258
	Cutblock 21–30	-0.434	0.333	-1.057	0.260	-1.300	0.193
	Cutblock 31–40	-1.316	0.485	-2.221	-0.287	-2.712	**0.007**
	Wildfire 0–10	0.126	0.291	-0.422	0.725	0.433	0.665
	Wildfire 11–20	0.433	0.289	-0.110	1.028	1.501	0.133
	Wildfire 21–30	0.261	0.254	-0.224	0.775	1.029	0.303
	Wildfire 31–40	0.066	0.263	-0.436	0.601	0.252	0.801
UBH	Intercept	2.808	0.168	2.491	3.153	16.672	**<0.001**
	Cutblock 0–10	0.051	0.297	-0.518	0.651	0.172	0.864
	Cutblock 11–20	-0.578	0.295	-1.147	0.014	-1.960	**0.050**
	Cutblock 21–30	-1.779	0.442	-2.642	-0.891	-4.022	**<0.001**
	Cutblock 31–40	-0.155	0.372	-0.851	0.620	-0.417	0.677
	Wildfire 0–10	0.314	0.284	-0.232	0.887	1.107	0.268
	Wildfire 11–20	0.014	0.278	-0.523	0.572	0.052	0.959
	Wildfire 21–30	-0.357	0.376	-1.063	0.425	-0.950	0.342
	Wildfire 31–40	-0.444	0.284	-0.992	0.124	-1.565	0.118

Notes: [a] NSR = natural subregion, CM = Central Mixedwood, F = Foothills, LBH = Lower Boreal Highlands, UBH = Upper Boreal Highlands; [b] numbers displayed in strata category refer to time since disturbance (years).

Table A20. The effects of strata (disturbance type and time since disturbance) on bear shrubs. Reference category is 'Caribou use >40'. 2.5% and 97.5% CI refer to the lower and upper confidence intervals. Significant differences are displayed in bold.

NSR [a]	Strata category [b]	Estimate	Std. Error	2.5% CI	97.5% CI	t value	*P-value*
CM	Intercept	-1.836	0.343	-2.556	-1.200	-5.360	**<0.001**
	Cutblock 0–10	2.817	0.602	1.708	4.097	4.682	**<0.001**
	Cutblock 11–20	3.209	0.483	2.306	4.208	6.648	**<0.001**
	Cutblock 21–30	2.675	0.508	1.721	3.727	5.260	**<0.001**
	Cutblock 31–40	3.446	0.675	2.238	4.944	5.108	**<0.001**
	Wildfire 0–10	1.977	0.446	1.131	2.888	4.432	**<0.001**
	Wildfire 11–20	0.563	0.577	-0.597	1.692	0.976	0.329
	Wildfire 21–30	0.825	0.570	-0.308	1.951	1.446	0.148
	Wildfire 31–40	2.274	0.491	1.347	3.281	4.634	**<0.001**
F	Intercept	-2.434	0.360	-3.193	-1.765	-6.755	**<0.001**
	Cutblock 0–10	2.043	0.523	1.053	3.114	3.909	**<0.001**
	Cutblock 11–20	3.200	0.497	2.271	4.230	6.441	**<0.001**
	Cutblock 21–30	4.102	0.479	3.209	5.097	8.566	**<0.001**
	Cutblock 31–40	3.869	0.525	2.898	4.969	7.375	**<0.001**
	Wildfire 0–10	2.516	0.503	1.570	3.553	5.001	**<0.001**
	Wildfire 11–20	0.236	1.228	-2.847	2.486	0.193	0.847
	Wildfire 21–30	2.616	0.988	0.874	4.996	2.648	**0.008**
LBH	Intercept	-0.097	0.293	-0.647	0.511	-0.331	0.740
	Cutblock 0–10	0.240	0.652	-0.965	1.654	0.369	0.712
	Cutblock 11–20	1.096	0.604	-0.009	2.417	1.814	0.070
	Cutblock 21–30	1.655	0.631	0.520	3.067	2.623	**0.009**
	Cutblock 31–40	1.564	0.845	0.134	3.649	1.850	0.064
	Wildfire 0–10	-0.884	0.688	-2.237	0.521	-1.284	0.199
	Wildfire 11–20	-1.982	0.898	-4.010	-0.307	-2.207	**0.027**
	Wildfire 31–40	-0.308	0.571	-1.403	0.867	-0.540	0.589

Notes: Missing strata categories are due to 0 abundance of forage group in respective sites; no abundance of forage group in reference category (caribou use sites) in UBH NSR; [a] NSR = natural subregion, CM = Central Mixedwood, F = Foothills, LBH = Lower Boreal Highlands, UBH = Upper Boreal Highlands; [b] numbers displayed in strata category refer to time since disturbance (years); [c] 2.5% CI = lower confidence interval, 97.5% CI = upper confidence interval

Supporting tables (Section 3.3.2)

Table A21. Summary output of final models for ***caribou forbs*** *in cutblock, wildfire, and caribou use sites. 2.5% and 97.5% CI refer to the lower and upper confidence intervals. Significance is indicated in bold. Variables are described in Table 2.*

Site	Variable	Estimate	Std. Error	2.5% CI	97.5% CI	z value	*P* value
Cutblock	Intercept	1.130	0.318	0.402	1.875	3.554	**<0.001**
	BA	-0.094	0.025	-0.155	-0.035	-3.733	**<0.001**
	BA.d	-0.190	0.130	-0.723	-0.038	-1.459	0.145
	CC	0.012	0.006	-0.003	0.028	1.921	0.055
	CS	0.031	0.037	-0.041	0.118	0.846	0.398
	dCWD	0.025	0.020	-0.019	0.071	1.267	0.205
	DT	0.043	0.015	0.009	0.077	2.810	**0.005**
	NSR (CM)	0.826	0.389	-0.014	1.794	2.122	**0.034**
	NSR (F)	0.624	0.223	0.147	1.083	2.801	**0.005**
	NSR (LBH)	-0.662	0.304	-1.282	-0.028	-2.178	**0.029**
	NSR (UBH)	-0.788	0.345	-1.486	-0.047	-2.281	**0.023**
	SD	-0.041	0.009	-0.060	-0.023	-4.615	**<0.001**
	BA:NSR (CM)	0.084	0.027	0.024	0.147	3.073	**0.002**
	BA:NSR (F)	0.077	0.026	0.016	0.140	3.001	**0.003**
	BA:NSR (LBH)	-0.050	0.046	-0.156	0.056	-1.082	0.279
	BA:NSR (UBH)	-0.110	0.049	-0.248	0.013	-2.265	**0.024**
	BA:SD	0.001	0.001	-0.001	0.002	1.217	0.224
	BA.d:NSR (CM)	0.211	0.132	0.053	0.745	1.605	0.108
	BA.d:NSR (F)	0.111	0.133	-0.053	0.646	0.835	0.404
	BA.d:NSR (LBH)	0.182	0.134	0.015	0.719	1.362	0.173
	BA.d:NSR (UBH)	-0.504	0.388	-2.103	-0.061	-1.301	0.193
	CC:NSR (CM)	-0.042	0.009	-0.063	-0.023	-4.932	**0.000**
	CC:NSR (F)	-0.022	0.007	-0.040	-0.004	-2.876	**0.004**
	CC:NSR (LBH)	0.026	0.011	0.001	0.053	2.437	**0.015**
	CC:NSR (UBH)	0.038	0.013	0.005	0.076	2.982	**0.003**
Wildfire	Intercept	2.849	0.261	2.322	3.401	10.906	**<0.001**
	BA	-0.012	0.009	-0.031	0.007	-1.289	0.198
	BA.d	-0.237	0.095	-0.496	-0.081	-2.498	**0.013**
	CC	-0.004	0.005	-0.015	0.007	-0.819	0.413
	CS	-0.012	0.009	-0.027	0.006	-1.314	0.189
	DT	-0.013	0.010	-0.036	0.009	-1.333	0.182
	NSR (CM)	-0.643	0.194	-1.017	-0.262	-3.310	**0.001**
	NSR (F)	0.234	0.211	-0.176	0.662	1.113	0.266
	NSR (LBH)	-0.038	0.175	-0.385	0.316	-0.214	0.830
	NSR (UBH)	0.447	0.220	0.037	0.895	2.030	**0.042**
	SD	-0.022	0.003	-0.029	-0.016	-6.382	**<0.001**

Site	Variable	Estimate	Std. Error	2.5% CI	97.5% CI	z value	*P* value
Wildfire	BA.d:NSR (CM)	0.213	0.096	0.055	0.473	2.230	**0.026**
	BA.d:NSR (F)	0.233	0.095	0.077	0.492	2.445	**0.014**
	BA.d:NSR (LBH)	0.173	0.097	0.011	0.435	1.776	0.076
	BA.d:NSR (UBH)	-0.619	0.282	-1.393	-0.164	-2.199	**0.028**
Caribou use	Intercept	3.078	0.351	2.346	3.846	8.767	**<0.001**
	BA	-0.024	0.013	-0.050	0.002	-1.885	0.059
	BA.d	-0.097	0.042	-0.174	-0.015	-2.281	**0.023**
	CC	-0.004	0.005	-0.014	0.006	-0.781	0.435
	CS	-0.033	0.032	-0.095	0.030	-1.042	0.297
	dCWD	-0.061	0.028	-0.112	-0.007	-2.187	**0.029**
	DT	0.002	0.003	-0.004	0.008	0.620	0.535
	NSR (CM)	-0.075	0.267	-0.660	0.508	-0.280	0.779
	NSR (F)	-0.955	0.257	-1.522	-0.408	-3.725	**<0.001**
	NSR (LBH)	0.516	0.251	-0.004	1.031	2.052	**0.040**
	NSR (UBH)	0.514	0.474	-0.445	1.604	1.084	0.279
	SD	-0.026	0.004	-0.035	-0.018	-6.781	**<0.001**
	BA:NSR (CM)	-0.004	0.018	-0.041	0.034	-0.229	0.819
	BA:NSR (F)	0.042	0.010	0.020	0.063	4.161	**<0.001**
	BA:NSR (LBH)	-0.024	0.012	-0.048	-0.001	-2.042	**0.041**
	BA:NSR (UBH)	-0.013	0.019	-0.056	0.028	-0.699	0.485
	BA:SD	0.000	0.000	-0.001	0.000	-0.886	0.375
	BA.d:NSR (CM)	0.108	0.047	0.019	0.194	2.322	**0.020**
	BA.d:NSR (F)	-0.201	0.100	-0.383	-0.034	-2.015	**0.044**
	BA.d:NSR (LBH)	0.056	0.047	-0.033	0.140	1.192	0.233
	BA.d:NSR (UBH)	0.037	0.087	-0.122	0.236	0.429	0.668

Notes: BA = basal area (all), BA.d = deciduous basal area (all), CC = canopy cover, CS= coniferous saplings, dCWD = downed coarse woody debris, DT = time since disturbance, NSR (CM) = Central Mixedwood, NSR (F) = Foothills, NSR (LBH) = Lower Boreal Highlands, NSR (UBH) = Upper Boreal Highlands. ":" indicates an interaction. Deviation coding was used for categorical variables.

*Table A22. Summary output of final models for **caribou lichens** in cutblock, wildfire, and caribou use sites. 2.5% and 97.5% CI refer to the lower and upper confidence intervals. Significance is indicated in bold.*

Site	Variable	Estimate	Std. Error	2.5% CI	97.5% CI	z value	*P* value
Cutblock	Intercept	-0.749	0.270	-1.307	-0.202	-2.774	**0.006**
	BA	-0.026	0.012	-0.052	-0.001	-2.169	**0.030**
	BA.d	-0.047	0.016	-0.080	-0.017	-2.927	**0.003**
	CC	0.003	0.004	-0.005	0.012	0.822	0.411
	CS	0.049	0.029	-0.016	0.119	1.678	0.093
	dCWD	0.031	0.017	-0.004	0.066	1.820	0.069
	DT	0.065	0.013	0.038	0.093	5.120	**<0.001**
	NSR (CM)	-0.264	0.190	-0.650	0.118	-1.390	0.164
	NSR (F)	0.271	0.133	0.004	0.539	2.044	**0.041**
	NSR (LBH)	0.565	0.158	0.258	0.879	3.583	**<0.001**
	NSR (UBH)	0.572	0.214	-0.999	-0.156	-2.666	**0.008**
	SD	-0.015	0.005	-0.025	-0.005	-2.888	**0.004**
Wildfire	Intercept	0.752	0.264	0.214	1.298	2.853	**0.004**
	BA	-0.018	0.010	-0.037	0.002	-1.819	0.069
	BA.d	-0.052	0.030	-0.124	0.002	-1.712	0.087
	CC	-0.007	0.005	-0.017	0.004	-1.531	0.126
	dCWD	0.028	0.009	0.009	0.048	3.102	**0.002**
	DT	0.044	0.008	0.027	0.061	5.497	**<0.001**
	NSR (CM)	0.453	0.220	0.020	0.891	2.054	**0.040**
	NSR (F)	-1.418	0.372	-2.164	-0.687	-3.808	**<0.001**
	NSR (LBH)	0.182	0.220	-0.247	0.618	0.826	0.409
	NSR (UBH)	0.783	0.308	0.232	1.369	2.542	**0.011**
	SD	-0.008	0.004	-0.015	0.000	-2.084	**0.037**
	BA:NSR (CM)	0.046	0.015	0.015	0.081	2.966	**0.003**
	BA:NSR (F)	0.015	0.014	-0.013	0.043	1.123	0.261
	BA:NSR (LBH)	-0.030	0.015	-0.060	0.000	-1.997	**0.046**
	BA:NSR (UBH)	-0.032	0.015	-0.063	-0.001	-2.069	**0.039**
	BA:SD	<0.001	<0.001	-0.001	<0.001	-0.765	0.444
	BA.d:NSR (CM)	-0.012	0.037	-0.081	0.068	-0.323	0.747
	BA.d:NSR (F)	0.038	0.033	-0.024	0.114	1.171	0.242
	BA.d:NSR (LBH)	0.065	0.039	-0.009	0.150	1.652	0.099
	BA.d:NSR (UBH)	-0.091	0.084	-0.297	0.055	-1.082	0.279
	CC:NSR (CM)	-0.019	0.006	-0.032	-0.007	-3.328	**0.001**
	CC:NSR (F)	0.021	0.009	-0.002	0.045	2.245	**0.025**
	CC:NSR (LBH)	0.007	0.006	-0.006	0.020	1.166	0.244
	CC:NSR (UBH)	-0.009	0.007	-0.023	0.006	-1.310	0.190
Caribou use	Intercept	4.711	0.440	3.794	5.713	10.711	**<0.001**
	BA	-0.020	0.019	-0.064	0.027	-1.065	0.288
	BA.d	-0.177	0.100	-0.425	0.006	-1.763	0.079

Site	Variable	Estimate	Std. Error	2.5% CI	97.5% CI	z value	*P* value
	CC	-0.013	0.010	-0.033	0.008	-1.323	0.187
	CS	-0.007	0.050	-0.115	0.109	-0.138	0.890
	NSR (CM)	-1.128	0.450	-2.116	-0.169	-2.509	**0.013**
	NSR (F)	-2.139	0.464	-3.160	-1.169	-4.608	**<0.001**
	NSR (LBH)	1.830	0.448	0.745	2.944	4.087	**<0.001**
	NSR (UBH)	1.437	0.865	-0.346	3.547	1.661	0.098
	SD	-0.034	0.005	-0.045	-0.024	-7.075	**<0.001**
	BA:NSR (CM)	0.074	0.039	-0.017	0.183	1.908	0.058
	BA:NSR (F)	-0.008	0.023	-0.062	0.042	-0.366	0.714
	BA:NSR (LBH)	-0.028	0.026	-0.087	0.031	-1.058	0.291
	BA:NSR (UBH)	-0.038	0.041	-0.129	0.058	-0.932	0.352
	BA.d:NSR (CM)	-0.023	0.110	-0.236	0.241	-0.210	0.834
	BA.d:NSR (F)	-0.310	0.273	-1.024	0.065	-1.136	0.257
	BA.d:NSR (LBH)	0.054	0.107	-0.139	0.309	0.509	0.611
	BA.d:NSR (UBH)	0.279	0.151	0.032	0.716	1.842	0.067
	CC:NSR (CM)	0.010	0.016	-0.023	0.046	0.639	0.524
	CC:NSR (F)	0.016	0.013	-0.011	0.044	1.193	0.234
	CC:NSR (LBH)	-0.012	0.015	-0.045	0.022	-0.805	0.422
	CC:NSR (UBH)	-0.014	0.020	-0.057	0.028	-0.704	0.482

Notes: BA = basal area (all), BA.d = deciduous basal area (all), CC = canopy cover, CS= coniferous saplings, dCWD = downed coarse woody debris, DT = time since disturbance, NSR (CM) = Central Mixedwood, NSR (F) = Foothills, NSR (LBH) = Lower Boreal Highlands, NSR (UBH) = Upper Boreal Highlands. ":" indicates an interaction. Deviation coding was used for categorical variables.

Table A23. Summary output of final models for ***moose forbs*** *in cutblock, wildfire, and caribou use sites. 2.5% and 97.5% CI refer to the lower and upper confidence intervals. Significance is indicated in bold.*

Site	Variable	Estimate	Std. Error	2.5% CI	97.5% CI	z value	*P* value
Cutblock	Intercept	2.882	0.131	2.624	3.146	21.925	**<0.001**
	BA	0.005	0.011	-0.015	0.026	0.480	0.632
	BA.d	-0.021	0.009	-0.039	-0.003	-2.450	**0.014**
	CC	-0.002	0.003	-0.008	0.004	-0.652	0.514
	DT	-0.011	0.009	-0.027	0.005	-1.294	0.196
	NSR (CM)	-0.123	0.202	-0.525	0.304	-0.607	0.544
	NSR (F)	-0.168	0.122	-0.412	0.074	-1.369	0.171
	NSR (LBH)	0.321	0.157	0.013	0.643	2.045	**0.041**
	NSR (UBH)	-0.031	0.184	-0.383	0.346	-0.167	0.868
	SD	0.003	0.003	-0.003	0.009	0.866	0.387
	BA:NSR (CM)	0.032	0.012	0.010	0.055	2.752	**0.006**
	BA:NSR (F)	-0.008	0.011	-0.029	0.014	-0.661	0.509
	BA:NSR (LBH)	0.014	0.019	-0.020	0.050	0.749	0.454
	BA:NSR (UBH)	-0.039	0.022	-0.080	0.002	-1.785	0.074
	CC:NSR (CM)	-0.010	0.004	-0.019	-0.002	-2.496	**0.013**
	CC:NSR (F)	0.005	0.004	-0.003	0.012	1.262	0.207
	CC:NSR (LBH)	-0.009	0.006	-0.019	0.002	-1.620	0.105
	CC:NSR (UBH)	0.014	0.006	0.003	0.026	2.359	**0.018**
Wildfire	Intercept	2.775	0.129	2.509	3.045	21.438	**<0.001**
	CC	-0.006	0.002	-0.010	-0.002	-3.128	**0.002**
	CS	-0.010	0.005	-0.019	-0.001	-2.082	**0.037**
	dCWD	0.006	0.006	-0.005	0.018	1.169	0.242
	NSR (CM)	0.200	0.114	-0.028	0.429	1.751	0.080
	NSR (F)	-0.706	0.151	-1.003	-0.402	-4.682	**<0.001**
	NSR (LBH)	0.240	0.111	0.019	0.463	2.167	**0.030**
	NSR (UBH)	0.266	0.163	-0.058	0.605	1.635	0.102
	SD	0.004	0.002	0.001	0.008	2.756	**0.006**
	CC:NSR (CM)	-0.009	0.003	-0.014	-0.004	-3.650	**<0.001**
	CC:NSR (F)	0.018	0.004	0.010	0.026	4.665	**<0.001**
	CC:NSR (LBH)	-0.004	0.003	-0.009	0.001	-1.510	0.131
	CC:NSR (UBH)	-0.005	0.003	-0.012	0.002	-1.477	0.140
Caribou use	Intercept	2.693	0.180	2.332	3.064	14.969	**<0.001**
	BA	-0.021	0.007	-0.036	-0.007	-2.923	**0.003**
	BA.d	0.021	0.019	-0.018	0.064	1.110	0.267
	CC	-0.007	0.003	-0.013	0.000	-1.872	0.061
	CS	0.025	0.017	-0.011	0.061	1.418	0.156
	dCWD	-0.009	0.017	-0.042	0.024	-0.530	0.596
	NSR (CM)	-0.411	0.155	-0.723	-0.104	-2.657	**0.008**
	NSR (F)	-0.188	0.151	-0.497	0.117	-1.241	0.215

Site	Variable	Estimate	Std. Error	2.5% CI	97.5% CI	z value	*P* value
	NSR (LBH)	0.556	0.159	0.235	0.875	3.490	**<0.001**
	NSR (UBH)	0.043	0.331	-0.617	0.739	0.131	0.896
	SD	0.001	0.002	-0.004	0.005	0.315	0.752
	BA:NSR (CM)	0.009	0.012	-0.015	0.033	0.730	0.466
	BA:NSR (F)	0.006	0.008	-0.009	0.022	0.797	0.425
	BA:NSR (LBH)	-0.007	0.010	-0.027	0.012	-0.727	0.467
	BA:NSR (UBH)	-0.008	0.016	-0.039	0.023	-0.542	0.588
	BA:SD	<0.001	<0.001	<0.001	<0.001	2.581	**0.010**
	BA.d:NSR (CM)	-0.008	0.021	-0.054	0.035	-0.368	0.713
	BA.d:NSR (F)	-0.032	0.034	-0.103	0.041	-0.967	0.333
	BA.d:NSR (LBH)	0.029	0.021	-0.016	0.070	1.410	0.158
	BA.d:NSR (UBH)	0.011	0.048	-0.087	0.125	0.234	0.815
	CC:NSR (CM)	0.004	0.005	-0.005	0.013	0.874	0.382
	CC:NSR (F)	0.001	0.005	-0.008	0.010	0.181	0.856
	CC:NSR (LBH)	-0.009	0.006	-0.020	0.002	-1.653	0.098
	CC:NSR (UBH)	0.004	0.008	-0.011	0.020	0.538	0.591

Notes: BA = basal area (all), BA.d = deciduous basal area (all), CC = canopy cover, CS= coniferous saplings, dCWD = downed coarse woody debris, DT = time since disturbance, NSR (CM) = Central Mixedwood, NSR (F) = Foothills, NSR (LBH) = Lower Boreal Highlands, NSR (UBH) = Upper Boreal Highlands. ":" indicates an interaction. Deviation coding was used for categorical variables.

Table A24. Summary output of final models for moose saplings in cutblock, wildfire, and caribou use sites. 2.5% and 97.5% CI refer to the lower and upper confidence intervals. Significance is indicated in bold.

Site	Variable	Estimate	Std. Error	2.5% CI	97.5% CI	z value	*P* value
Cutblock	Intercept	3.495	0.253	2.987	4.034	13.811	**<0.001**
	BA	-0.049	0.014	-0.077	-0.020	-3.434	**0.001**
	BA.d	0.024	0.015	-0.005	0.057	1.645	0.100
	CC	0.021	0.005	0.011	0.030	4.541	**<0.001**
	CS	0.176	0.039	0.074	0.287	4.556	**<0.001**
	DT	-0.046	0.015	-0.078	-0.013	-2.997	**0.003**
	NSR (CM)	1.952	0.370	1.253	2.758	5.272	**<0.001**
	NSR (F)	-0.263	0.228	-0.738	0.205	-1.152	0.249
	NSR (LBH)	0.431	0.296	-0.133	1.040	1.458	0.145
	NSR (UBH)	-2.120	0.355	-2.770	-1.388	-5.976	**<0.001**
	SD	-0.019	0.005	-0.031	-0.005	-3.536	**<0.001**
	CC:NSR (CM)	-0.023	0.006	-0.035	-0.012	-4.063	**<0.001**
	CC:NSR (F)	0.008	0.004	-0.001	0.017	1.808	0.071
	CC:NSR (LBH)	-0.006	0.005	-0.017	0.004	-1.193	0.233
	CC:NSR (UBH)	0.022	0.006	0.010	0.034	3.397	**0.001**
Wildfire	Intercept	5.007	0.334	4.348	5.717	14.999	**<0.001**
	BA	-0.015	0.010	-0.035	0.006	-1.511	0.131
	BA.d	0.030	0.013	0.002	0.064	2.326	**0.020**
	CC	0.007	0.006	-0.005	0.019	1.212	0.225
	CS	0.014	0.010	-0.002	0.035	1.389	0.165
	dCWD	0.023	0.012	-0.003	0.052	1.883	0.060
	DT	-0.093	0.010	-0.114	-0.073	-9.050	**<0.001**
	NSR (CM)	0.551	0.266	-0.044	1.152	2.070	**0.038**
	NSR (F)	0.509	0.350	-0.313	1.407	1.456	0.145
	NSR (LBH)	-0.871	0.262	-1.416	-0.321	-3.328	**0.001**
	NSR (UBH)	-0.189	0.369	-0.931	0.645	-0.513	0.608
	SD	-0.020	0.004	-0.028	-0.013	-5.292	**<0.001**
	CC:NSR (CM)	-0.002	0.006	-0.015	0.011	-0.320	0.749
	CC:NSR (F)	-0.028	0.009	-0.052	-0.003	-2.990	**0.003**
	CC:NSR (LBH)	0.019	0.006	0.006	0.033	3.240	**0.001**
	CC:NSR (UBH)	0.010	0.008	-0.006	0.027	1.375	0.169
Caribou use	Intercept	1.961	1.000	-0.339	4.729	1.961	**0.050**
	BA	-0.082	0.032	-0.168	-0.012	-2.533	**0.011**
	BA.d	0.045	0.039	-0.045	0.150	1.146	0.252
	CS	-0.344	0.126	-0.678	-0.025	-2.716	**0.007**
	dCWD	0.037	0.080	-0.183	0.275	0.462	0.644
	DT	0.008	0.008	-0.009	0.029	0.935	0.350
	NSR (CM)	0.360	0.938	-1.943	2.719	0.383	0.702

Site	Variable	Estimate	Std. Error	2.5% CI	97.5% CI	z value	*P* value
	NSR (F)	-0.215	0.858	-2.283	1.664	-0.250	0.802
	NSR (LBH)	-2.751	1.081	-5.321	-0.486	-2.545	**0.011**
	NSR (UBH)	2.606	1.541	-1.334	7.882	1.691	0.091
	SD	-0.060	0.014	-0.097	-0.032	-4.284	**<0.001**
	BA:NSR (CM)	-0.009	0.041	-0.111	0.092	-0.221	0.825
	BA:NSR (F)	0.004	0.030	-0.067	0.085	0.130	0.897
	BA:NSR (LBH)	0.104	0.033	0.044	0.189	3.159	**0.002**
	BA:NSR (UBH)	-0.099	0.063	-0.307	0.075	-1.556	0.120
	BA:SD	0.002	0.001	0.001	0.003	3.463	**0.001**

Notes: BA = basal area (all), BA.d = deciduous basal area (all), CC = canopy cover, CS= coniferous saplings, dCWD = downed coarse woody debris, DT = time since disturbance, NSR (CM) = Central Mixedwood, NSR (F) = Foothills, NSR (LBH) = Lower Boreal Highlands, NSR (UBH) = Upper Boreal Highlands. ":" indicates an interaction. Deviation coding was used for categorical variables.

Table A25. Summary output of final models for ***moose shrubs*** *in cutblock, wildfire, and caribou use sites. 2.5% and 97.5% CI refer to the lower and upper confidence intervals. Significance is indicated in bold.*

Site	Variable	Estimate	Std. Error	2.5% CI	97.5% CI	z value	*P* value
Cutblock	Intercept	2.008	0.213	1.576	2.456	9.431	**<0.001**
	BA	-0.073	0.012	-0.096	-0.050	-6.162	**<0.001**
	BA.d	0.044	0.012	0.018	0.072	3.639	**<0.001**
	CC	0.018	0.004	0.011	0.026	5.034	**<0.001**
	CS	-0.078	0.035	-0.145	-0.009	-2.221	**0.026**
	dCWD	-0.152	0.021	-0.196	-0.109	-7.133	**<0.001**
	SD	0.002	0.004	-0.008	0.013	0.474	0.636
Wildfire	Intercept	1.398	0.217	0.961	1.850	6.429	**<0.001**
	BA	-0.016	0.008	-0.032	0.001	-1.923	0.055
	BA.d	0.027	0.019	-0.014	0.082	1.413	0.158
	CC	0.020	0.004	0.013	0.029	5.055	**<0.001**
	DT	-0.024	0.008	-0.039	-0.008	-2.950	**0.003**
	NSR (CM)	0.589	0.189	0.225	0.951	3.122	**0.002**
	NSR (F)	0.268	0.291	-0.286	0.852	0.923	0.356
	NSR (LBH)	-0.677	0.208	-1.089	-0.264	-3.249	**0.001**
	NSR (UBH)	-0.180	0.298	-0.803	0.474	-0.604	0.546
	SD	0.002	0.003	-0.003	0.008	0.835	0.404
	BA:NSR (CM)	-0.016	0.015	-0.041	0.012	-1.129	0.259
	BA:NSR (F)	-0.008	0.011	-0.029	0.014	-0.677	0.498
	BA:NSR (LBH)	0.036	0.012	0.010	0.063	2.902	**0.004**
	BA:NSR (UBH)	-0.012	0.013	-0.039	0.017	-0.867	0.386
	BA.d:NSR (CM)	-0.026	0.026	-0.087	0.025	-1.013	0.311
	BA.d:NSR (F)	-0.003	0.021	-0.059	0.042	-0.129	0.898
	BA.d:NSR (LBH)	-0.088	0.030	-0.164	-0.014	-2.970	**0.003**
	BA.d:NSR (UBH)	0.118	0.048	0.022	0.262	2.455	**0.014**
Caribou use	Intercept	-0.570	0.485	-1.695	0.566	-1.175	0.240
	BA	-0.021	0.015	-0.053	0.010	-1.387	0.165
	BA.d	-0.006	0.100	-0.344	0.142	-0.063	0.950
	CC	0.005	0.009	-0.013	0.024	0.632	0.527
	dCWD	0.051	0.043	-0.034	0.139	1.193	0.233
	DT	0.000	0.004	-0.009	0.009	0.006	0.995
	NSR (CM)	0.357	0.398	-0.560	1.243	0.898	0.369
	NSR (F)	-1.021	0.434	-1.999	-0.081	-2.354	**0.019**
	NSR (LBH)	0.631	0.428	-0.335	1.578	1.475	0.140
	NSR (UBH)	0.033	0.933	-2.157	2.385	0.036	0.971
	SD	0.013	0.004	0.003	0.022	2.973	**0.003**
	BA.d:NSR (CM)	-0.003	0.101	-0.156	0.334	-0.034	0.973
Caribou use	BA.d:NSR (F)	0.147	0.119	-0.059	0.510	1.233	0.217
	BA.d:NSR (LBH)	0.112	0.101	-0.041	0.450	1.101	0.271

Site	Variable	Estimate	Std. Error	2.5% CI	97.5% CI	z value	*P* value
	BA.d:NSR (UBH)	-0.256	0.290	-1.257	0.157	-0.880	0.379
	CC:NSR (CM)	0.007	0.009	-0.012	0.026	0.769	0.442
	CC:NSR (F)	0.009	0.008	-0.009	0.027	1.057	0.291
	CC:NSR (LBH)	-0.020	0.010	-0.041	0.000	-2.073	**0.038**
	CC:NSR (UBH)	0.004	0.015	-0.034	0.042	0.273	0.784

Notes: BA = basal area, BA.d = deciduous basal area, CC = canopy cover, CS= coniferous saplings, dCWD = downed coarse woody debris, DT = time since disturbance, NSR (CM) = Central Mixedwood, NSR (F) = Foothills, NSR (LBH) = Lower Boreal Highlands, NSR (UBH) = Upper Boreal Highlands. ":" indicates an interaction. Deviation coding was used for categorical variables.

*Table A26. Summary output of final models for **bear forbs** in cutblock, wildfire, and caribou use sites. 2.5% and 97.5% CI refer to the lower and upper confidence intervals. Significance is indicated in bold.*

Site	Variable	Estimate	Std. Error	2.5% CI	97.5% CI	z value	*P* value
Cutblock	Intercept	2.323	0.186	1.968	2.686	12.490	**<0.001**
	BA	-0.016	0.011	-0.039	0.007	-1.440	0.150
	BA.d	-0.050	0.018	-0.087	-0.014	-2.751	**0.006**
	CC	-0.003	0.003	-0.009	0.003	-1.037	0.300
	dCWD	0.014	0.013	-0.011	0.040	1.096	0.273
	DT	0.018	0.010	-0.002	0.039	1.871	0.061
	NSR (CM)	-0.160	0.181	-0.494	0.184	-0.884	0.377
	NSR (F)	-0.194	0.120	-0.437	0.048	-1.608	0.108
	NSR (LBH)	0.197	0.159	-0.114	0.523	1.242	0.214
	NSR (UBH)	0.157	0.179	-0.185	0.522	0.874	0.382
	SD	-0.005	0.003	-0.012	0.002	-1.497	0.134
	BA:NSR (CM)	0.025	0.013	-0.002	0.052	1.846	0.065
	BA:NSR (F)	0.011	0.010	-0.008	0.030	1.177	0.239
	BA:NSR (LBH)	-0.030	0.018	-0.066	0.007	-1.644	0.100
	BA:NSR (UBH)	-0.006	0.015	-0.035	0.025	-0.374	0.709
	BA.d:NSR (CM)	0.032	0.022	-0.012	0.076	1.469	0.142
	BA.d:NSR (F)	0.036	0.020	-0.005	0.077	1.755	0.079
	BA.d:NSR (LBH)	0.022	0.029	-0.033	0.077	0.773	0.439
	BA.d:NSR (UBH)	-0.090	0.048	-0.189	0.007	-1.864	0.062
Wildfire	Intercept	3.125	0.150	2.813	3.446	20.897	**<0.001**
	BA	-0.010	0.006	-0.023	0.004	-1.584	0.113
	BA.d	-0.033	0.015	-0.061	-0.005	-2.201	**0.028**
	CC	-0.012	0.003	-0.017	-0.006	-4.223	**<0.001**
	CS	-0.011	0.006	-0.023	0.002	-2.017	**0.044**
	DT	0.005	0.005	-0.006	0.015	0.878	0.380
	NSR (CM)	0.155	0.128	-0.112	0.422	1.214	0.225
	NSR (F)	-0.451	0.197	-0.830	-0.060	-2.291	**0.022**
	NSR (LBH)	0.237	0.132	-0.022	0.498	1.794	0.073
	NSR (UBH)	0.059	0.190	-0.324	0.459	0.312	0.755
	SD	-0.010	0.002	-0.015	-0.005	-4.321	**<0.001**
	BA:NSR (CM)	-0.015	0.010	-0.037	0.008	-1.477	0.140
	BA:NSR (F)	0.009	0.008	-0.007	0.024	1.119	0.263
	BA:NSR (LBH)	-0.008	0.008	-0.026	0.010	-0.990	0.322
	BA:NSR (UBH)	0.015	0.009	-0.003	0.033	1.688	0.091
	BA:SD	**<0.001**	**<0.001**	**<0.001**	0.001	2.713	**0.007**
	BA.d:NSR (CM)	0.031	0.019	-0.007	0.069	1.629	0.103
	BA.d:NSR (F)	0.039	0.016	0.010	0.069	2.474	**0.013**
Wildfire	BA.d:NSR (LBH)	0.015	0.022	-0.028	0.058	0.673	0.501
	BA.d:NSR (UBH)	-0.085	0.038	-0.154	-0.013	-2.236	**0.025**

Site	Variable	Estimate	Std. Error	2.5% CI	97.5% CI	z value	*P* value
Caribou use	Intercept	3.317	0.229	2.851	3.796	14.499	**<0.001**
	BA	-0.020	0.008	-0.035	-0.004	-2.546	**0.011**
	CC	-0.006	0.004	-0.014	0.001	-1.602	0.109
	CS	0.035	0.020	-0.004	0.076	1.772	0.076
	dCWD	-0.043	0.019	-0.078	-0.006	-2.290	**0.022**
	DT	0.002	0.002	-0.001	0.006	1.151	0.250
	NSR (CM)	-0.044	0.178	-0.411	0.318	-0.245	0.806
	NSR (F)	-1.094	0.185	-1.479	-0.718	-5.925	**<0.001**
	NSR (LBH)	0.839	0.188	0.461	1.216	4.457	**<0.001**
	NSR (UBH)	0.299	0.360	-0.403	1.060	0.830	0.407
	SD	-0.022	0.002	-0.028	-0.017	-8.976	**<0.001**
	BA:NSR (CM)	0.013	0.012	-0.010	0.037	1.073	0.283
	BA:NSR (F)	0.019	0.009	0.002	0.035	2.177	**0.029**
	BA:NSR (LBH)	-0.005	0.010	-0.026	0.015	-0.531	0.595
	BA:NSR (UBH)	-0.026	0.016	-0.060	0.008	-1.611	0.107
	BA:SD	<0.001	<0.001	<0.001	0.001	4.151	**<0.001**
	CC:NSR (CM)	-0.003	0.006	-0.014	0.008	-0.481	0.631
	CC:NSR (F)	0.008	0.005	-0.002	0.018	1.473	0.141
	CC:NSR (LBH)	-0.015	0.006	-0.027	-0.003	-2.300	**0.021**
	CC:NSR (UBH)	0.010	0.009	-0.007	0.026	1.122	0.262

Notes: BA = basal area (all), BA.d = deciduous basal area (all), CC = canopy cover, CS= coniferous saplings, dCWD = downed coarse woody debris, DT = time since disturbance, NSR (CM) = Central Mixedwood, NSR (F) = Foothills, NSR (LBH) = Lower Boreal Highlands, NSR (UBH) = Upper Boreal Highlands. ":" indicates an interaction. Deviation coding was used for categorical variables.

*Table A27. Summary output of final models for **bear shrubs** in cutblock, wildfire, and caribou use sites. 2.5% and 97.5% CI refer to the lower and upper confidence intervals. Significance is indicated in bold.*

Site	Variable	Estimate	Std. Error	2.5% CI	97.5% CI	z value	*P* value
Cutblock	Intercept	1.702	0.299	1.094	2.337	5.695	**<0.001**
	BA	-0.035	0.016	-0.066	-0.003	-2.208	**0.027**
	BA.d	0.053	0.013	0.027	0.081	4.101	**<0.001**
	CC	0.018	0.004	0.009	0.028	4.106	**<0.001**
	CS	-0.199	0.048	-0.300	-0.102	-4.163	**<0.001**
	dCWD	-0.140	0.025	-0.190	-0.091	-5.666	**<0.001**
	DT	-0.030	0.015	-0.062	0.002	-1.991	**0.047**
	NSR (CM)	-0.081	0.307	-0.692	0.562	-0.263	0.792
	NSR (BH)	0.684	0.228	0.208	1.163	3.002	**0.003**
	NSR (F)	-0.603	0.222	-1.060	-0.155	-2.721	**0.007**
	BA:NSR (CM)	0.026	0.015	-0.003	0.054	1.768	0.077
	BA:NSR (BH)	0.005	0.020	-0.032	0.044	0.243	0.808
	BA:NSR (F)	-0.031	0.014	-0.059	-0.002	-2.139	**0.032**
	CC:NSR (CM)	-0.013	0.006	-0.025	-0.001	-2.265	**0.024**
	CC:NSR (BH)	-0.011	0.006	-0.024	0.002	-1.798	0.072
	CC:NSR (F)	0.024	0.005	0.013	0.036	4.416	**<0.001**
Wildfire	Intercept	0.361	0.379	-0.375	1.118	0.953	0.340
	BA	-0.029	0.013	-0.058	-0.001	-2.172	**0.030**
	BA.d	0.044	0.015	0.012	0.078	2.945	**0.003**
	CC	0.025	0.006	0.011	0.040	3.922	**<0.001**
	CS	-0.065	0.028	-0.123	-0.014	-2.354	**0.019**
	DT	-0.038	0.014	-0.065	-0.012	-2.769	**0.006**
	NSR (CM)	0.365	0.290	-0.214	0.961	1.262	0.207
	NSR (BH)	-1.208	0.319	-1.965	-0.492	-3.787	**<0.001**
	NSR (F)	0.843	0.360	0.025	1.659	2.339	**0.019**
	SD	-0.032	0.008	-0.050	-0.016	-3.856	**<0.001**
	BA:NSR (CM)	-0.015	0.012	-0.042	0.013	-1.225	0.221
	BA:NSR (BH)	0.046	0.012	0.017	0.077	3.848	**0.000**
	BA:NSR (F)	-0.031	0.011	-0.057	-0.005	-2.832	**0.005**
	BA:SD	0.001	<0.001	<0.001	0.002	2.485	**0.013**
Caribou use	Intercept	-2.307	1.643	-6.474	0.881	-1.404	0.160
	BA	0.029	0.037	-0.052	0.122	0.783	0.434
	BA.d	0.013	0.092	-0.168	0.167	0.139	0.890
	CC	0.009	0.022	-0.036	0.061	0.400	0.689
	CS	-0.683	0.266	-1.278	-0.207	-2.568	**0.010**
	dCWD	0.095	0.093	-0.103	0.274	1.024	0.306
	DT	-0.012	0.011	-0.039	0.011	-1.089	0.276
Caribou use	NSR (CM)	-3.407	2.444	-11.223	0.508	-1.394	0.163
	NSR (BH)	3.749	1.402	1.225	7.804	2.674	**0.007**

Site	Variable	Estimate	Std. Error	2.5% CI	97.5% CI	z value	*P* value
	NSR (F)	-0.341	1.833	-4.223	4.181	-0.186	0.852
	SD	-0.035	0.019	-0.085	-0.001	-1.830	0.067
	BA:NSR (CM)	0.082	0.062	-0.052	0.244	1.314	0.189
	BA:NSR (BH)	-0.005	0.041	-0.100	0.080	-0.130	0.897
	BA:NSR (F)	-0.077	0.039	-0.174	0.006	-1.944	0.052
	BA:SD	0.002	0.001	0.001	0.003	2.726	**0.006**
	BA.d:NSR (CM)	-0.061	0.097	-0.243	0.368	-0.630	0.529
	BA.d:NSR (BH)	0.135	0.094	-0.022	NA	1.448	0.148
	BA.d:NSR (F)	-0.074	0.179	NA	0.228	-0.416	0.678
	CC:NSR (CM)	0.029	0.035	-0.040	0.126	0.835	0.403
	CC:NSR (BH)	-0.069	0.028	-0.133	-0.016	-2.502	**0.012**
	CC:NSR (F)	0.041	0.028	-0.020	0.099	1.472	0.141

Notes: BA = basal area (all), BA.d = deciduous basal area (all), CC = canopy cover, CS= coniferous saplings, dCWD = downed coarse woody debris, DT = time since disturbance, NSR (CM) = Central Mixedwood, NSR (BH) = boreal highlands, NSR (F) = Foothills. Bear shrubs were not observed in the Upper Boreal Highlands in the caribou use sites, so data from the Lower Boreal Highlands and Upper Boreal Highlands were combined for the analysis of this forage group. ":" indicates an interaction. Deviation coding was used for categorical variables.

Supporting figures (Section 3.3.2)

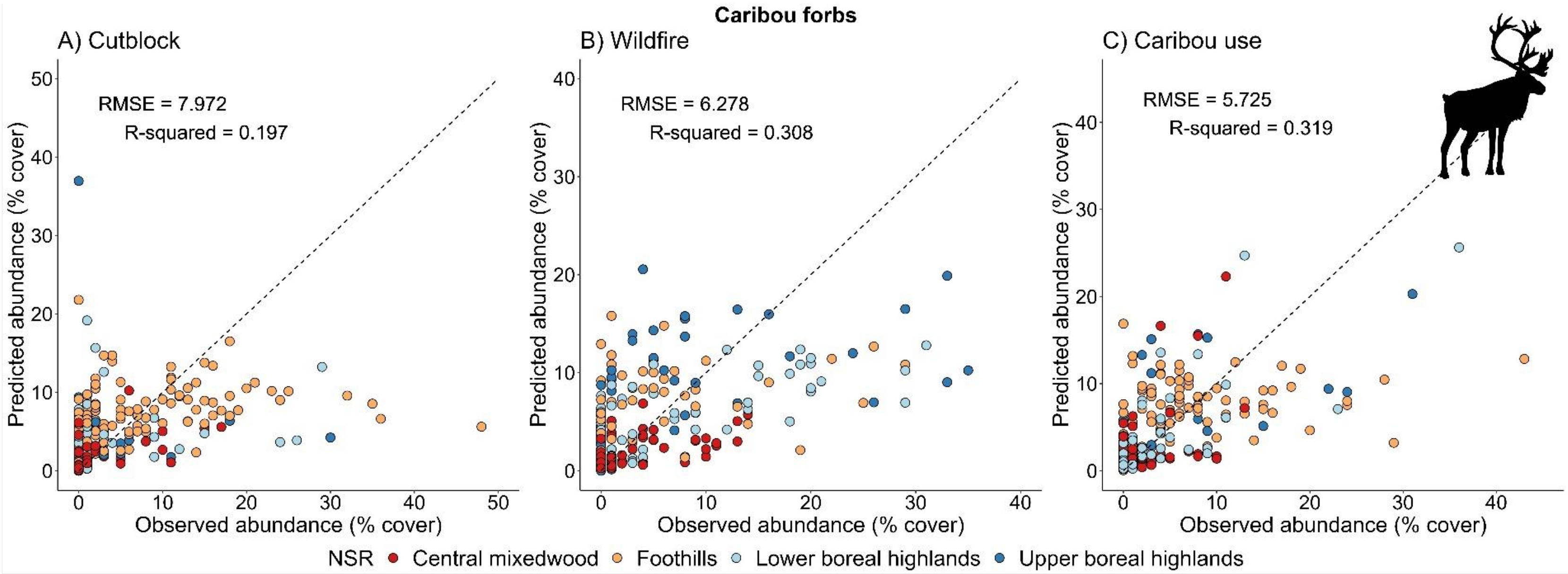

*Figure A6. Observed compared to predicted values from final models for abundance of **caribou forbs** (% cover) in A) cutblock, B) wildfire, and C) caribou use sites in Alberta, Canada. Natural subregions (NSR): red circles represent Central Mixedwood, orange for Foothills, light blue for Lower Boreal Highlands, and dark blue for Upper Boreal Highlands. Predicted values were generated from 20-fold cross validation. R-squared and RMSE values presented on plots were calculated from cross validation. Dashed lines represent a '1:1' slope line for reference of model predictive accuracy. Animal silhouette obtained from R package "rphylopic" (Gearty & Jones, 2023).*

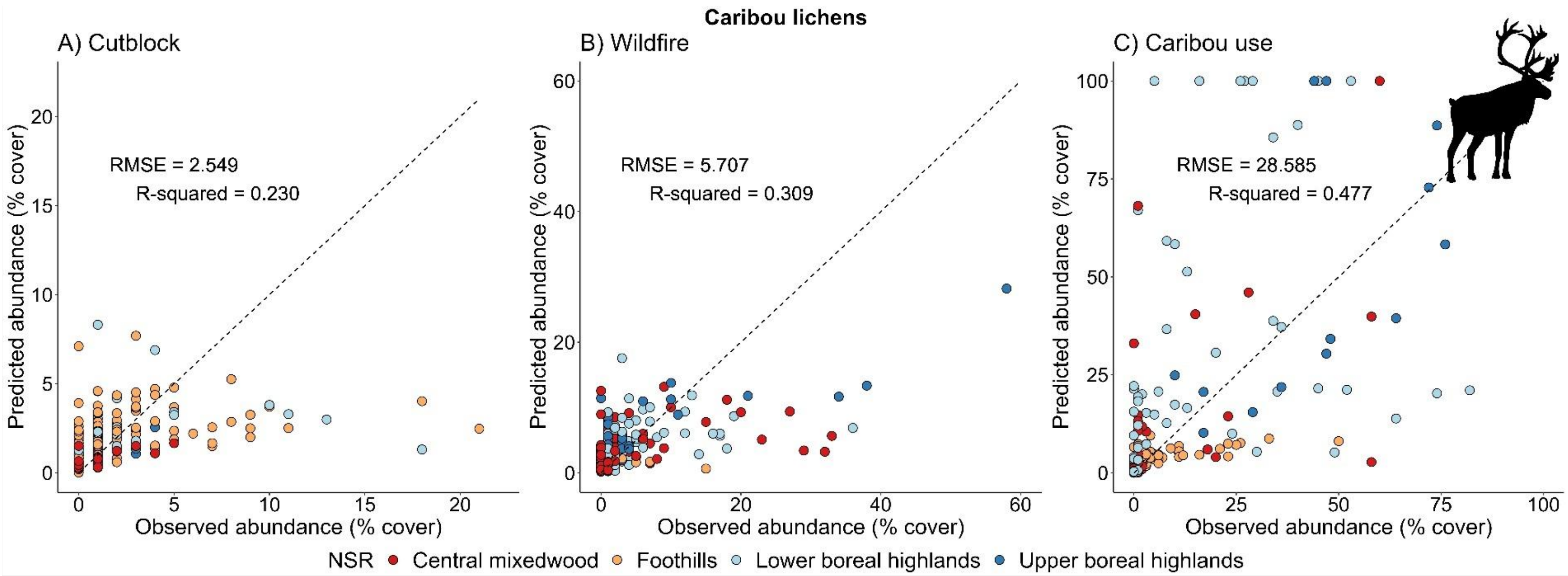

*Figure A7. Observed compared to predicted values from final models for abundance of **caribou lichens** (% cover) in A) cutblock, B) wildfire, and C) caribou use sites in Alberta, Canada. Natural subregions (NSR): red circles represent Central Mixedwood, orange for Foothills, light blue for Lower Boreal Highlands, and dark blue for Upper Boreal Highlands. Predicted values were generated from 20-fold cross validation. R-squared and RMSE values presented on plots were calculated from cross validation. Dashed lines represent a '1:1' slope line for reference of model predictive accuracy. Animal silhouette obtained from R package "rphylopic" (Gearty & Jones, 2023).*

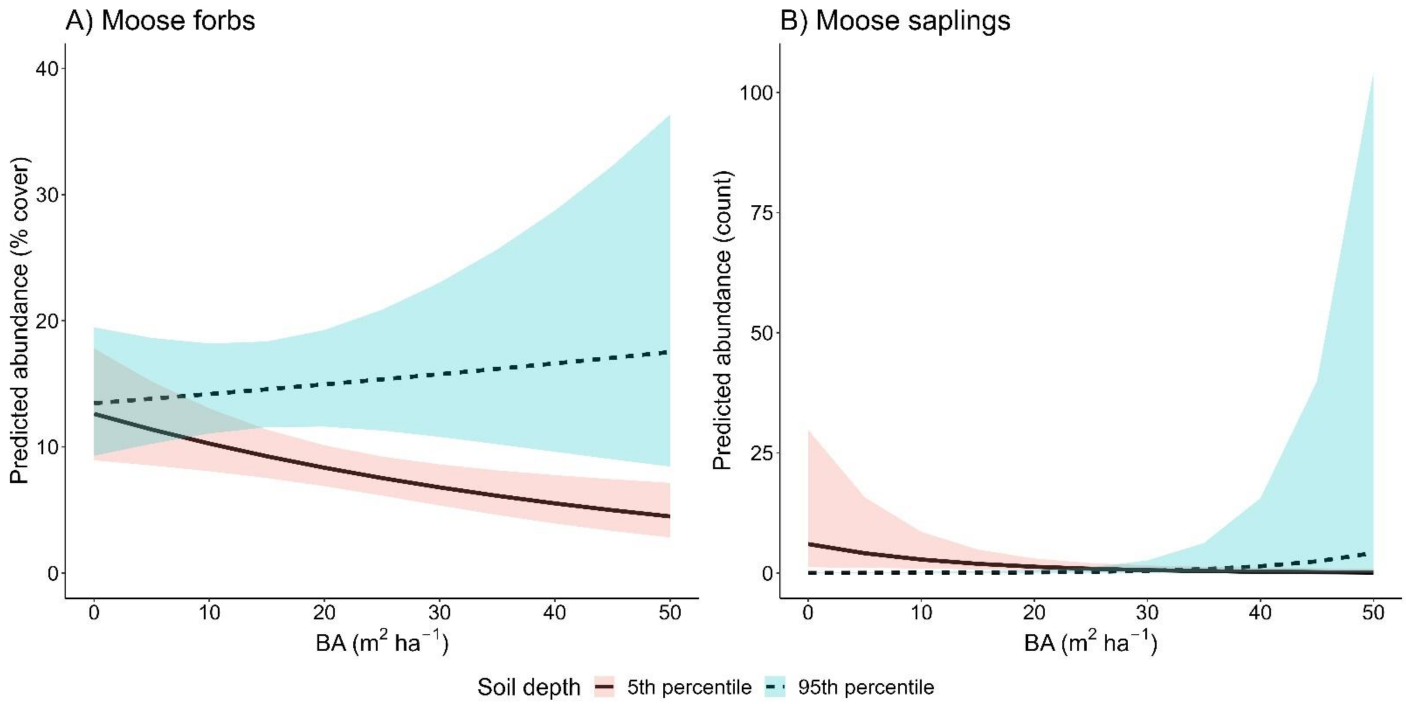

Figure A8. Predicted abundance of A) moose forbs (% cover), and B) moose saplings (count) based on interactions between soil depth and basal area (BA) in caribou use sites. Solid lines represent the 5th percentile of soil depth, and dashed lines represent the 95th percentile. Red and blue shading represent the lower and upper (95%) confidence intervals for the 5th and 95th percentile of soil depth, respectively.

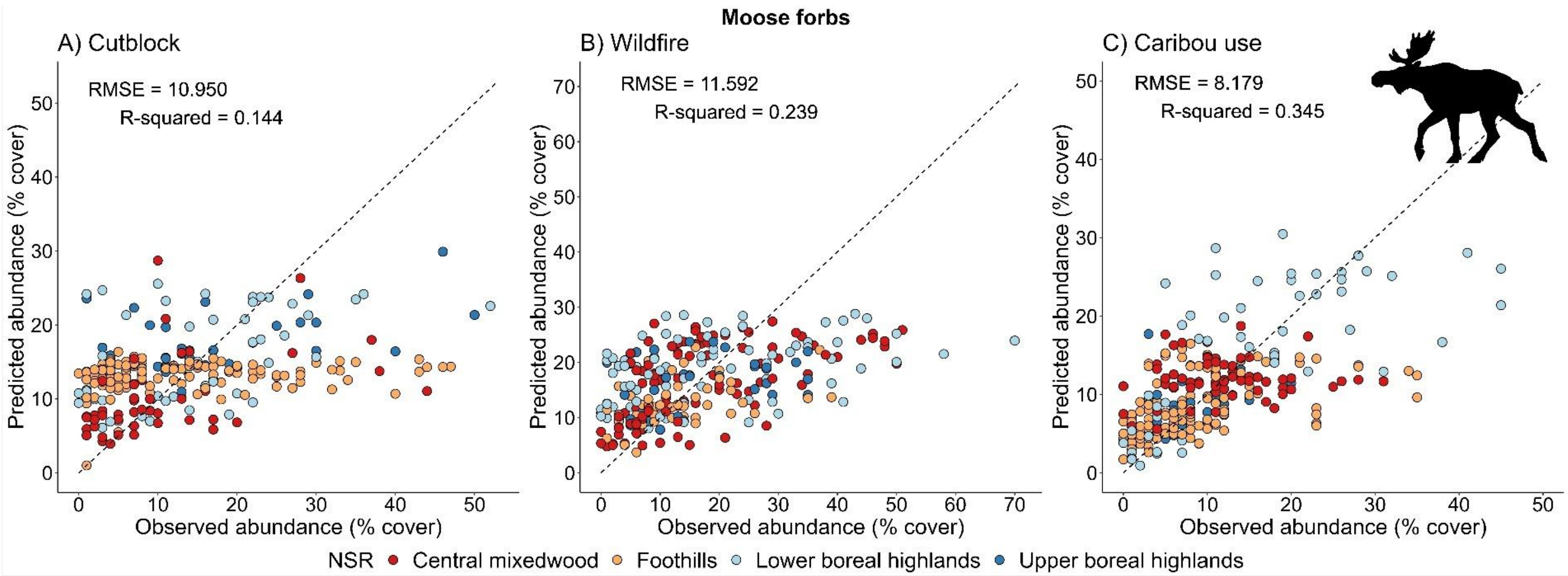

*Figure A9. Observed compared to predicted values from final models for abundance of **moose forbs** (% cover) in A) cutblock, B) wildfire, and C) caribou use sites in Alberta, Canada. Natural subregions (NSR): red circles represent Central Mixedwood, orange for Foothills, light blue for Lower Boreal Highlands, and dark blue for Upper Boreal Highlands. Predicted values were generated from 20-fold cross validation. R-squared and RMSE values presented on plots were calculated from cross validation. Dashed lines represent a '1:1' slope line for reference of model predictive accuracy. Animal silhouette obtained from R package "rphylopic" (Gearty & Jones, 2023).*

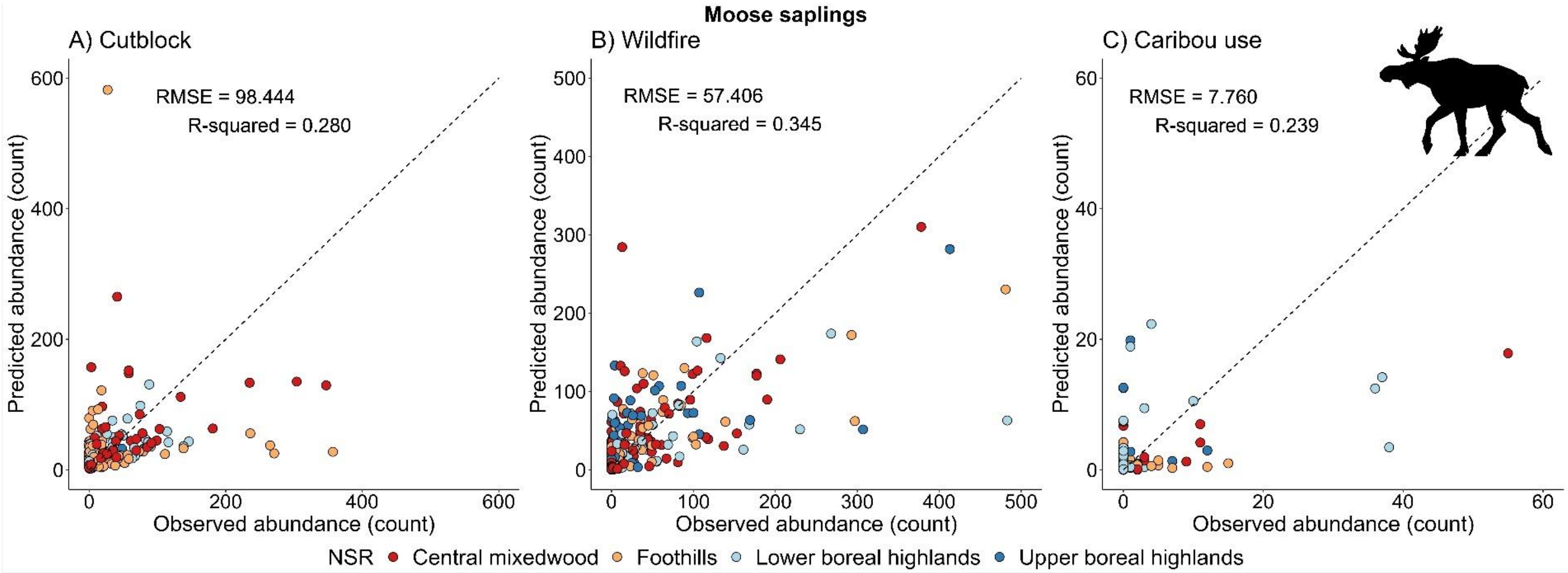

*Figure A10. Observed compared to predicted values from final models for abundance of **moose saplings** (count) in A) cutblock, B) wildfire, and C) caribou use sites in Alberta, Canada. Natural subregions (NSR): red circles represent Central Mixedwood, orange for Foothills, light blue for Lower Boreal Highlands, and dark blue for Upper Boreal Highlands. Predicted values were generated from 20-fold cross validation. R-squared and RMSE values presented on plots were calculated from cross validation. Dashed lines represent a '1:1' slope line for reference of model predictive accuracy. Animal silhouette obtained from R package "rphylopic" (Gearty & Jones, 2023).*

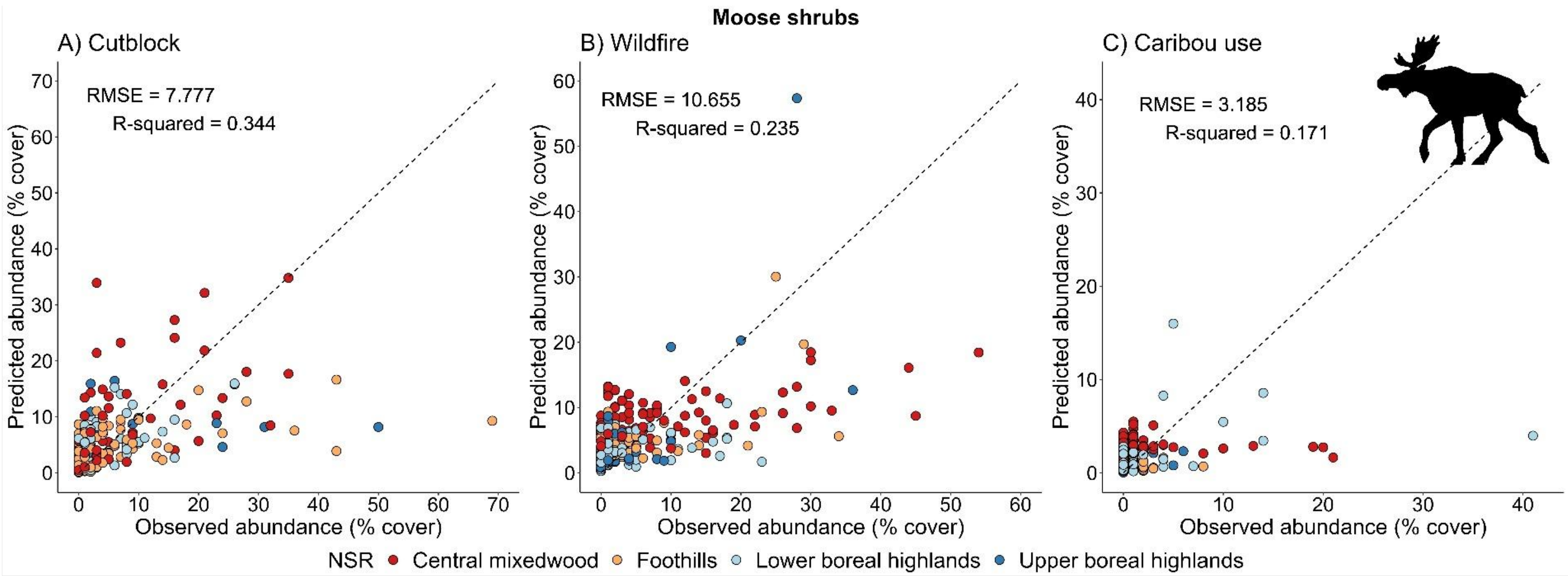

*Figure A11. Observed compared to predicted values from final models for abundance of **moose shrubs** (% cover) in A) cutblock, B) wildfire, and C) caribou use sites in Alberta, Canada. Natural subregions (NSR): red circles represent Central Mixedwood, orange for Foothills, light blue for Lower Boreal Highlands, and dark blue for Upper Boreal Highlands. Predicted values were generated from 20-fold cross validation. R-squared and RMSE values presented on plots were calculated from cross validation. Dashed lines represent a '1:1' slope line for reference of model predictive accuracy. Animal silhouette obtained from R package "rphylopic" (Gearty & Jones, 2023).*

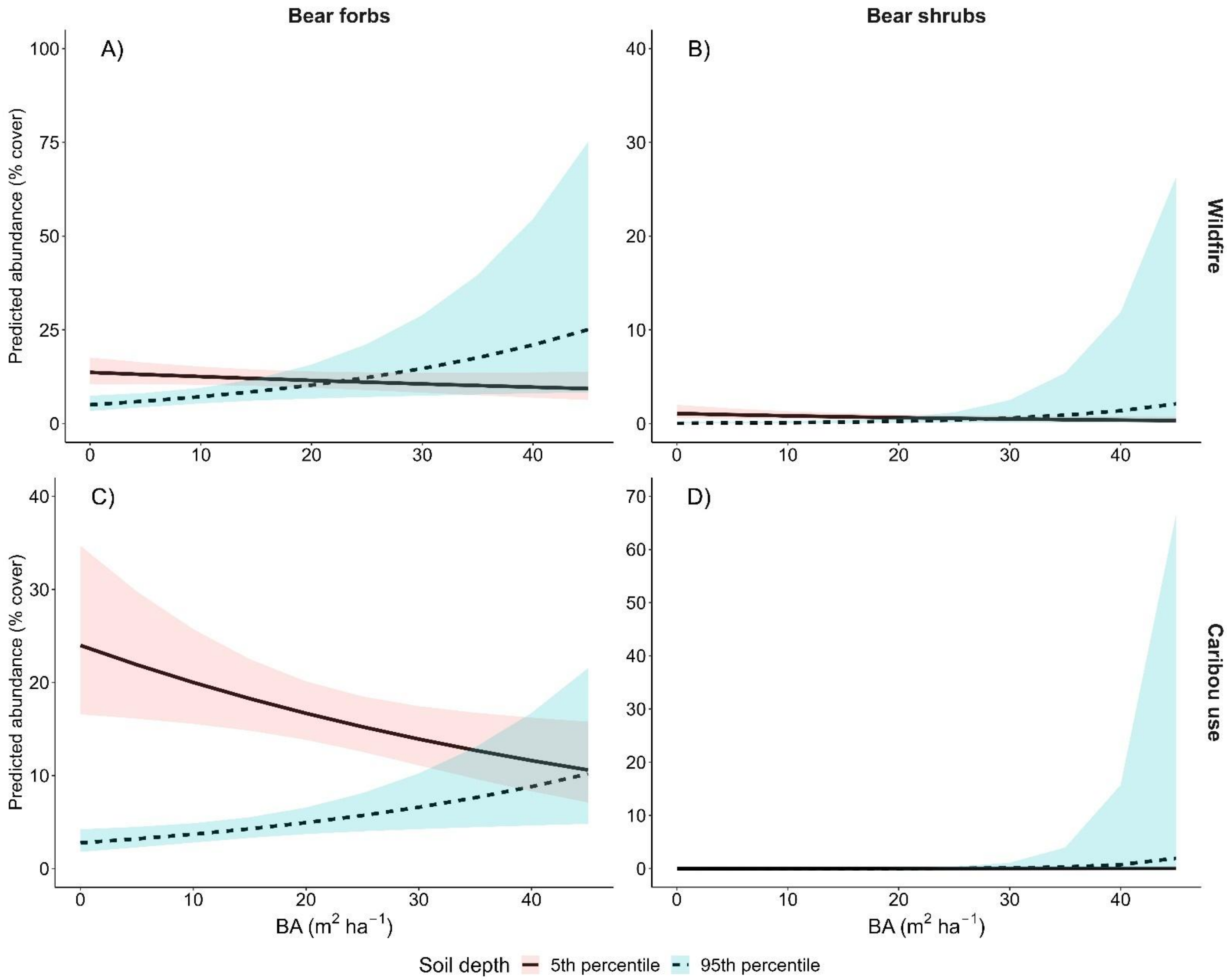

Figure A12. Predicted abundance of A) bear forbs in wildfire sites, B) bear shrubs in wildfire sites, C) bear forbs in caribou use sites, and D) bear shrubs in caribou use sites based on interactions between soil depth and basal area (BA). Solid lines represent the 5th percentile of soil depth, and dashed lines represent the 95th percentile. Red and blue shading represent the lower and upper (95%) confidence intervals for the 5th and 95th percentile of soil depth, respectively.

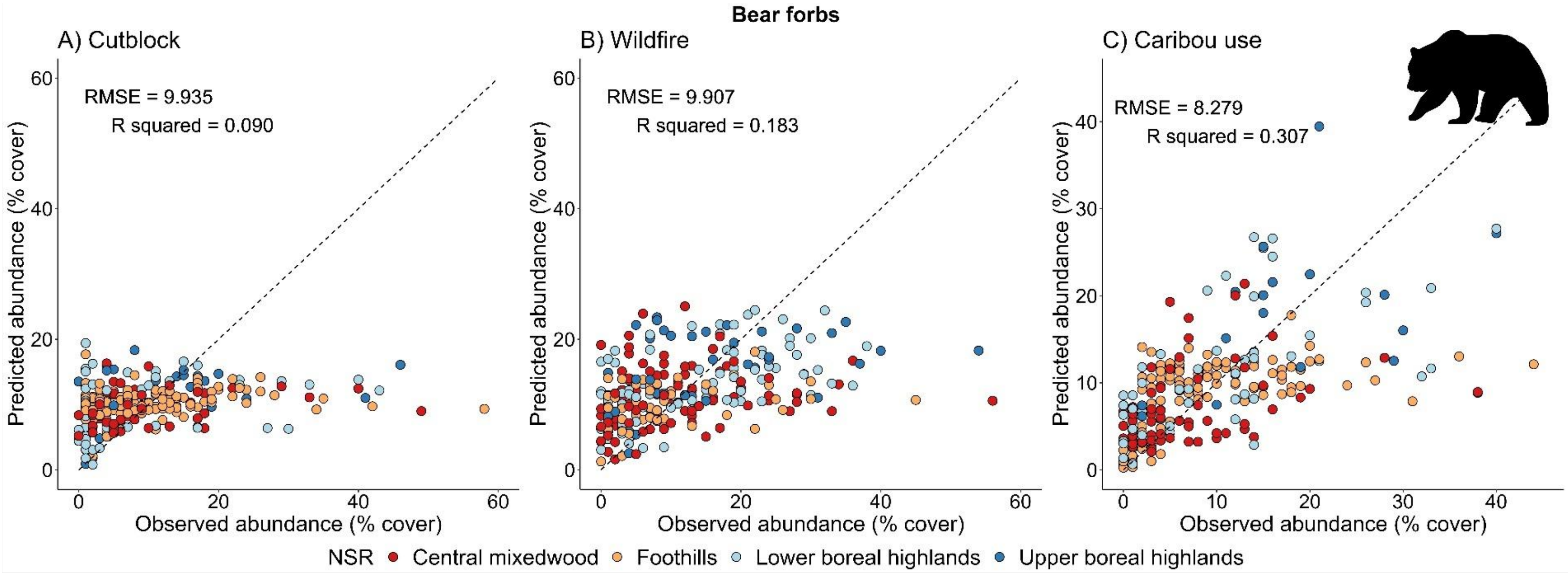

*Figure A13. Observed compared to predicted values from final models for abundance of **bear forbs** (% cover) in A) cutblock, B) wildfire, and C) caribou use sites in Alberta, Canada. Natural subregions (NSR): red circles represent Central Mixedwood, orange for Foothills, light blue for Lower Boreal Highlands, and dark blue for Upper Boreal Highlands. Predicted values were generated from 20-fold cross validation. R-squared and RMSE values presented on plots were calculated from cross validation. Dashed lines represent a '1:1' slope line for reference of model predictive accuracy. Animal silhouette obtained from R package "rphylopic" (Gearty & Jones, 2023).*

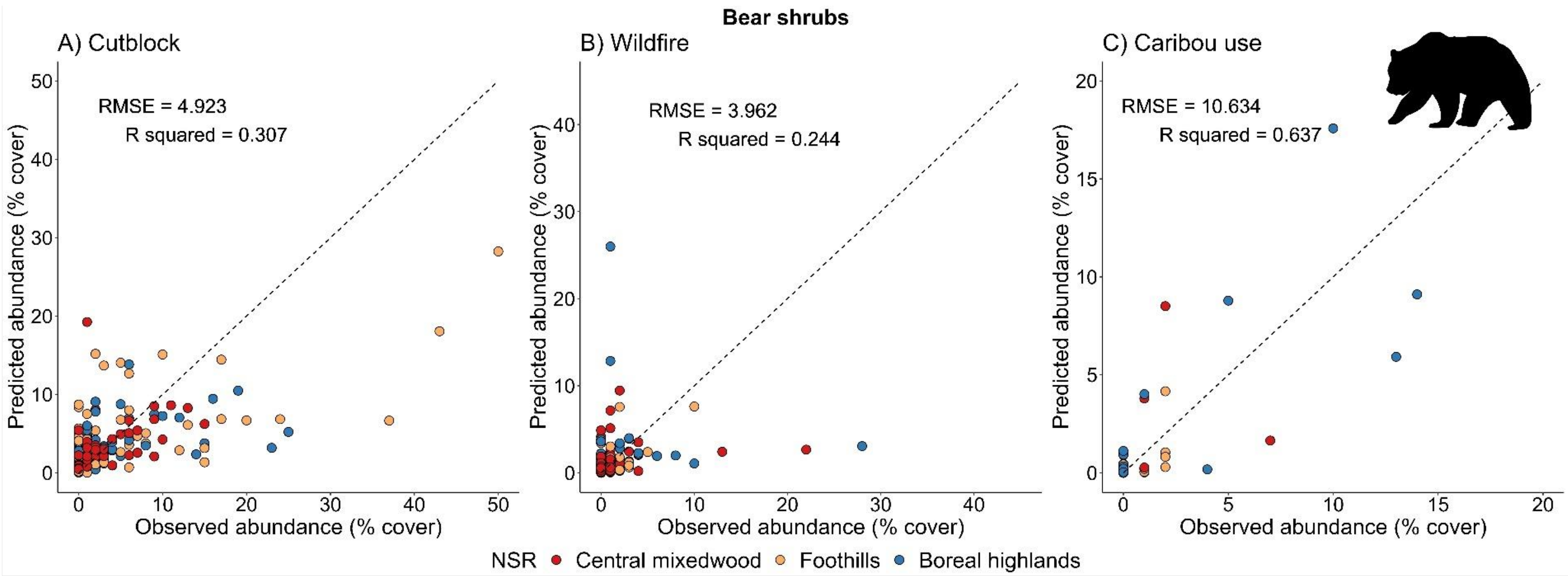

*Figure A14. Observed compared to predicted values from final models for abundance of **bear shrubs** (% cover) in A) cutblock, B) wildfire, and C) caribou use sites in Alberta, Canada. Natural subregions (NSR): red circles represent Central Mixedwood, orange for Foothills, and dark blue for boreal highlands. Predicted values were generated from 20-fold cross validation. R-squared and RMSE values presented on plots were calculated from cross validation. Dashed lines represent a '1:1' slope line for reference of model predictive accuracy. Animal silhouette obtained from R package "rphylopic" (Gearty & Jones, 2023).*

Supporting tables (Chapter 4)

Table A28. Model structure of most parsimonious models for forage groups (response variables) determined by model selection (Based on results from Section 3.3.2).

Response variable	Site	Predictor variables
Global model		BA + BA.d + CC + CS + CWD + DT + NSR + SD + BA:SD + BA:NSR + BA.d:NSR + CC:NSR
Caribou forbs	Cutblock	BA + BA.d + CC + CS + CWD + DT + NSR + SD + BA:SD + BA:NSR + BA.d:NSR + CC:NSR
	Wildfire	BA + BA.d + CC + CS + DT + NSR + SD + BA.d:NSR
Caribou lichens	Cutblock	BA + BA.d + CC + CS + CWD + DT + NSR + SD
	Wildfire	BA + BA.d + CC + CWD + DT + NSR + SD + BA:NSR + BA:SD + BA.d:NSR + CC:NSR
Moose forbs	Cutblock	BA + BA.d + CC + DT + NSR + SD + BA:NSR + CC:NSR
	Wildfire	CC + CS + CWD + NSR + SD + CC:NSR
Moose saplings	Cutblock	BA + BA.d + CC + CS + DT + NSR + SD + CC:NSR
	Wildfire	BA + BA.d + CC + CS + CWD + DT + NSR + SD + CC:NSR
Moose shrubs	Cutblock	BA + BA.d + CC + CS + CWD + SD
	Wildfire	BA + BA.d + CC + DT + NSR + SD + BA:NSR + BA.d:NSR
Bear forbs	Cutblock	BA + BA.d + CC + CWD + DT + NSR + SD + BA:NSR + BA.d:NSR
	Wildfire	BA + BA.d + CC + CS + DT + NSR + SD + BA:NSR + BA:SD + BA.d:NSR.C
Bear shrubs	Cutblock	BA + BA.d + CC + CS + CWD + DT + NSR + BA:NSR + CC:NSR
	Wildfire	BA + BA.d + CC + CS + DT + NSR + SD + BA:NSR + BA:SD

Notes: covariates: BA = basal area, BA.d = deciduous basal area, CC = canopy cover, CS = coniferous saplings, CWD = coarse woody debris, DT = time since disturbance, SD = soil depth; factor: NSR = natural subregion. ":" indicates an interaction between parameters.

Table A29. Effect sizes (partial η^2) of parameters for explaining variation of projected values for stand characteristics (timber supply). 95% confidence intervals are expressed in square brackets.

Parameter	**BA.Alive**	**BA.d.Alive**	**BA.c.Alive**	**QMD**	**SPH**
Disturbance type	0.10	0.005	0.10	0.09	0.006
	[0.09, 1.00]	[0.00, 1.00]	[0.10, 1.00]	[0.08, 1.00]	[0.00, 1.00]
NSR	0.17	0.01	0.17	0.02	0.06
	[0.16, 1.00]	[0.01, 1.00]	[0.16, 1.00]	[0.02, 1.00]	[0.05, 1.00]
Site index	0.05	0.01	0.02	0.04	<0.001
	[0.05, 1.00]	[0.01, 1.00]	[0.01, 1.00]	[0.03, 1.00]	[0.00, 1.00]
Projected time	0.31	0.03	0.17	0.50	0.34
	[0.30, 1.00]	[0.03, 1.00]	[0.16, 1.00]	[0.49, 1.00]	[0.33, 1.00]
Disturbance type: NSR	0.02	0.06	0.004	0.02	0.005
	[0.02, 1.00]	[0.06, 1.00]	[0.00, 1.00]	[0.02, 1.00]	[0.00, 1.00]
Site index: NSR	<0.001	<0.001	<0.001	0.001	0.002
	[0.00, 1.00]	[0.00, 1.00]	[0.00, 1.00]	[0.00, 1.00]	[0.00, 1.00]

Notes: Upper limit of 95% CI set to 1.00. All variables only include alive trees. BA.Alive = basal area (alive trees), BA.d.Alive = deciduous basal area (alive trees), BA.c.Alive = coniferous basal area (alive trees), QMD = quadratic mean diameter, SPH = stems per hectare. Categories of parameters: Disturbance type = cutblock, wildfire; Natural subregion (NSR) = Central Mixedwood, Foothills, Lower Boreal Highlands, Upper Boreal Highlands; Site index = low, intermediate, high; Projected time = 0, 10, 20, … 100 (0 represents sampling year 2021 or 2022).

Table A30. Effect sizes (partial η^2) of parameters for explaining variation of projected values for stand characteristics. 95% confidence intervals are expressed in square brackets.

Parameter	Canopy cover	Coniferous saplings	dCWD
Disturbance type	0.07 [0.07, 1.00]	0.12 [0.11, 1.00]	0.03 [0.02, 1.00]
NSR	0.009 [0.01, 1.00]	0.02 [0.01, 1.00]	0.005 [0.00, 1.00]
Site index	0.002 [0.00, 1.00]	0.002 [0.00, 1.00]	<0.001 [0.00, 1.00]
Projected time	0.57 [0.56, 1.00]	0.24 [0.23, 1.00]	0.38 [0.37, 1.00]
Disturbance type: NSR	0.002 [0.00, 1.00]	0.01 [0.01, 1.00]	0.004 [0.00, 1.00]
Site index: NSR	0.006 [0.00, 1.00]	<0.001 [0.00, 1.00]	<0.001 [0.00, 1.00]

Notes: Upper limit of 95% CI set to 1.00. All variables only include alive trees.Categories of parameters: Disturbance type = cutblock, wildfire; Natural subregion (NSR) = Central Mixedwood, Foothills, Lower Boreal Highlands, Upper Boreal Highlands; Site index = low, intermediate, high; Projected time = 0, 10, 20, … 100 (0 represents sampling year 2021 or 2022).

Table A31. Effect sizes (partial η^2) of parameters for explaining variation of predicted abundance of forage groups. 95% confidence intervals are expressed in square brackets.

Parameter	Caribou forbs	Caribou lichens	Moose forbs	Moose saplings	Moose shrubs	Bear forbs	Bear shrubs
Disturbance type	0.18 [0.17, 1.00]	0.03 [0.03, 1.00]	0.14 [0.14, 1.00]	0.01 [0.01, 1.00]	0.02 [0.02, 1.00]	0.27 [0.26, 1.00]	0.06 [0.06, 1.00]
NSR	0.04 [0.04, 1.00]	0.26 [0.25, 1.00]	0.42 [0.42, 1.00]	<0.001 [0.00, 1.00]	0.07 [0.06, 1.00]	0.13 [0.12, 1.00]	0.03 [0.02, 1.00]
Site index	0.005 [0.00, 1.00]	0.02 [0.01, 1.00]	<0.001 [0.00, 1.00]	<0.001 [0.00, 1.00]	<0.001 [0.00, 1.00]	0.003 [0.00, 1.00]	<0.001 [0.00, 1.00]
Projected time	0.007 [0.00, 1.00]	0.15 [0.14, 1.00]	0.18 [0.17, 1.00]	0.31 [0.30, 1.00]	0.002 [0.00, 1.00]	0.009 [0.01, 1.00]	0.02 [0.02, 1.00]
Disturbance type: NSR	0.03 [0.03, 1.00]	0.05 [0.04, 1.00]	0.43 [0.42, 1.00]	0.006 [0.00, 1.00]	0.08 [0.07, 1.00]	0.26 [0.25, 1.00]	0.01 [0.01, 1.00]
Site index: NSR	0.005 [0.00, 1.00]	0.006 [0.00, 1.00]	0.003 [0.00, 1.00]	<0.001 [0.00, 1.00]	0.005 [0.00, 1.00]	0.002 [0.00, 1.00]	0.002 [0.00, 1.00]

Notes: Upper limit of 95% CI set to 1.00. Categories of parameters: Disturbance type = cutblock, wildfire; Natural subregion (NSR) = Central Mixedwood, Foothills, Lower Boreal Highlands, Upper Boreal Highlands; Site index = low, intermediate, high; Projected time = 0, 10, 20, … 100 (0 represents sampling year 2021 or 2022). NSR categories for bear shrubs = Central Mixedwood, boreal highlands, Foothills.

Supporting figures (Chapter 4)

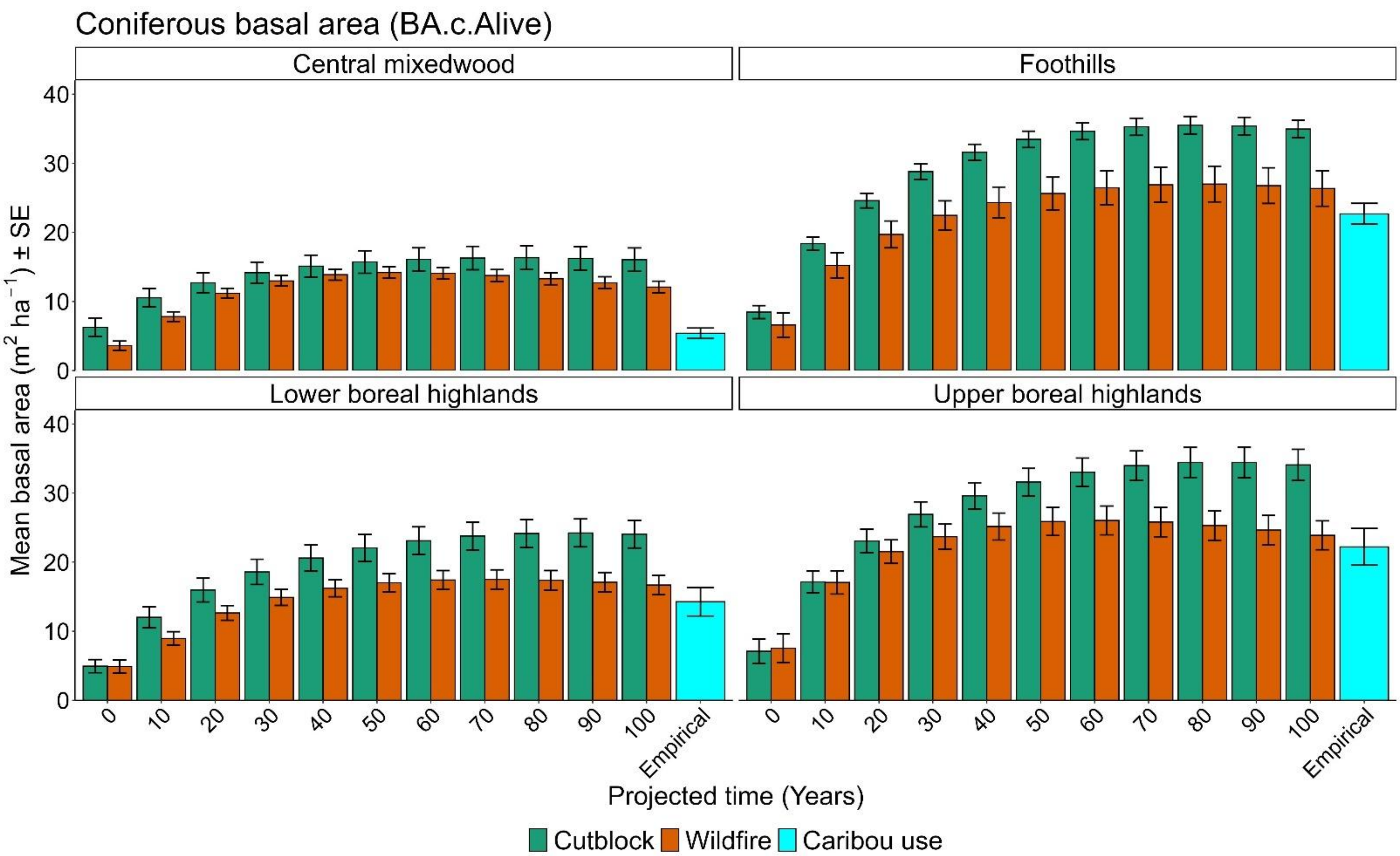

Figure A15. Mean values of coniferous basal area (BA.c.Alive) projected over 100 years in cutblock and wildfire sites across natural subregions, and compared to empirical values in caribou use sites. Values of cutblock and wildfire sites generated from MGM. Values of caribou use sites based on field data collected. For projected time, 0 represents sampling year 2021 or 2022. Error bars represent standard error (SE) of the mean.

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