

### Stand structure and regeneration

At MPB monitoring sites, lodgepole pine was the dominant canopy tree species at each site (Table S1). Hybrid white spruce (*Picea glauca x engelmannii*) contributed to the canopy at 98-Mile (Site 1), Phillip Lakes (Site 3), Laidman Lake (Site 7) and Jackfish Creek (Site 8), and subalpine fir (*Abies lasiocarpa*) contributed to the canopy at 98-Mile (Site 1) and Phillip Lakes (Site 3). Hybrid white spruce and willow (*Salix* sp.) made up a minor component of the canopy at South Discovery Creek (Site 12), and trembling aspen (*Populus tremuloides*) made up a minor component of the canopy at Jackfish Creek (Site 8).

The degree of MPB attack varied across sites (Table S1, Figure S1). By 2016 and 2017, Discovery Creek (Site 34), which was the site that contained the smallest diameter trees (see Table 1; main paper), contained the lowest percent of MPB attack and the highest density of residual live trees. The lowest density of residual live trees was at 98-Mile (Site 1), which was in part due to the high degree of blow-down at the site (see Coarse Woody Debris). Stand structure observed at 98-Mile (Site 1) in 2016 may not have been representative of original stand structure due to the high degree of blowdown. Residual live tree density was also low at Phillip Lakes (Site 3), Jackfish Creek (Site 8) and Upper Osilinka (Site 48).

Lodgepole pine was the dominant regeneration species at all sites (Table S2). Hybrid white spruce was present at all sites, and subalpine fir was present at all sites except for Malaput (Site 2), Laidman Lake (Site 7), and harvested treatments at 98-Mile (Site 1). Trembling aspen (*Populus tremuloides*) and willow were present in all five transitional sites: 98-Mile (Site 1), Malaput (Site 2), Laidman Lake (Site 7), Jackfish Creek (Site 8), and South Discovery Creek (Site 12), and was the dominant species in the Laidman Lake prescribed burn, and in the two harvesting treatments at the Malaput site (Site 2) that included tree planting. Regeneration in the No Harvest treatment at 98-Mile (Site 1), and at South Discovery Creek (Site 12), also included black spruce (*Picea mariana*). Alder (*Alnus* sp.) was only found in the No Harvest treatment at 98-Mile (Table S2).

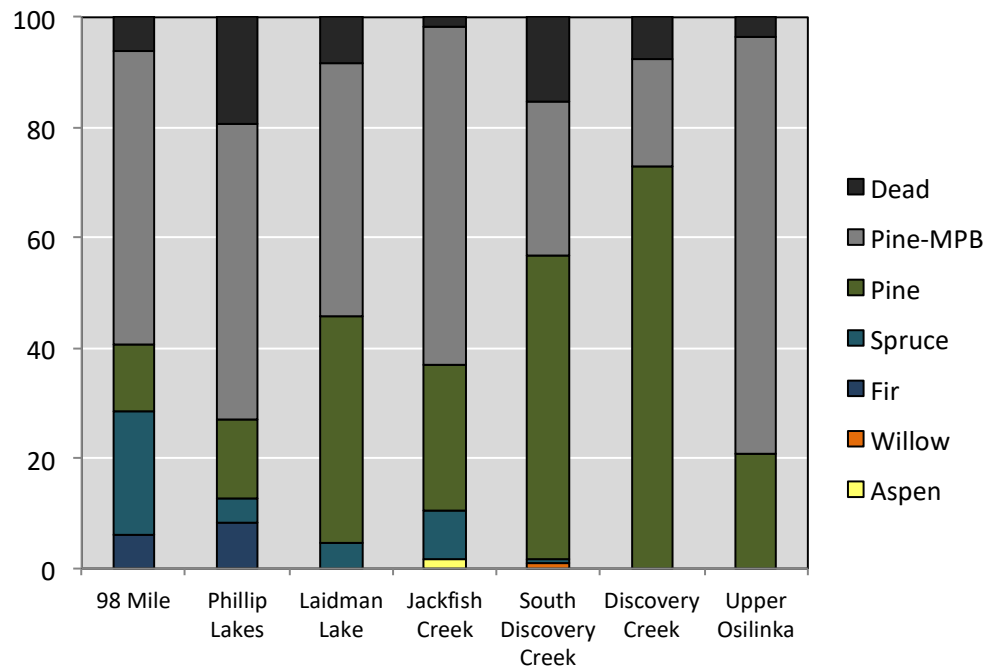
**Table S1.** Average density (stems/ha) and basal area (basal area/ha) of trees  $\geq 7.5$  cm dbh for each species/status for MPB monitoring sites in the Omineca area in 2016 and 2017.

Site <sup>1,2</sup>	Willow	Aspen	Fir	Hybrid spruce	Pine unk <sup>3</sup>	Pine	Dead-MPB	Dead	Total live	Total live (range)
Average stems/ha										
1 <sup>4</sup>	0	0	25	92	17	50	217	25	167	0 - 250
3	0	0	83	42	0	142	533	192	267	100 - 450
7	0	0	0	60	0	550	610	110	610	250 - 1300
8	0	17	0	83	0	250	583	17	350	100 - 600
12	17	0	0	17	17	964	489	266	998	564 - 1400
34	0	0	0	0	0	1633	433	167	1633	1100 - 2100
48	0	0	0	0	0	300	1100	50	300	0 - 800
Average basal area/ha										

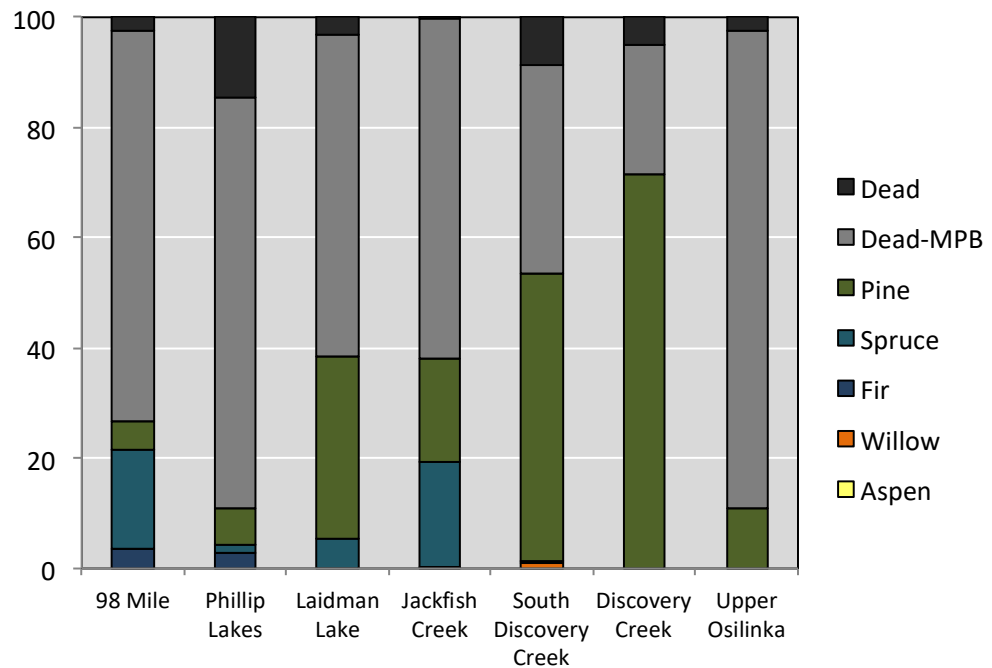
1 <sup>4</sup>	0	0	0.3	1.7	0.1	0.5	6.7	0.2	2.5	0 - 7.1
3	0	0	0.8	0.3	0	1.7	18.9	3.7	2.8	0.9 - 4.1
7	0	0	0	1.4	0	8.7	15.4	0.8	10.1	4.0 - 10.8
8	0	0.1	0	5.3	0	5.2	17.2	0.1	10.7	2.2 - 18.2
12	0.4	0	0	0.1	0.3	16.6	12.0	2.7	17.0	8.4 - 23.4
34	0	0	0	0	0	15.7	5.2	1.1	15.7	10.3 - 27.1
48	0	0	0	0	0	2.8	22.2	0.6	2.8	0 - 8.7

<sup>1</sup> Sites: 1 = 98-Mile; 3 = Phillip Lakes; 7 = Laidman Lake; 8 = Jackfish Creek; 12 = South Discovery Creek; 34 = Discovery Creek; 48 = Upper Osilinka. <sup>2</sup> N = 6 plots at each site. <sup>3</sup> Status information (alive or dead or dead-MPB) for three pine trees was not collected. <sup>4</sup> The 98-Mile site (Site 1) suffered a high degree of blowdown.

Regeneration densities varied across sites with the highest densities at Malaput (Site 2) and Laidman Lake (Site 7) in the Tweedsmuir-Entiako caribou range portion of the study area and the lowest density at Upper Osilinka (Site 48; Table S2). In the Omineca caribou ranges, total regeneration was higher at Phillip Lakes (Site 3) than at 98-Mile (Site 1) for all forest harvesting treatments. At Phillip Lakes (Site 3), the highest regeneration density was in the No Harvest treatment, averaging 14,450 stems/ha. Average densities at treatments 1, 2, 5 and 6 ranged from 8 917 to 11,667 stems/ha, and average density at treatments 3 and 4 were 4,800 to 6,058 stems/ha respectively. Density of regeneration may have been influenced by treatment location. Treatments 1, 2, 5 and 6 were located on the lower bench on the northwest side of the road that bisects the site, while treatments 3 and 4 were located on the slightly higher bench on the southeast side of the road. The only treatment that included planting was treatment 4. In 2016, treatment 4 at Phillip Lakes (Site 3) had the second lowest density of regeneration out of the 7 treatments (including No Harvest) at the site.



(A)



(B)

**Figure S1.** Average percent of trees  $\geq 7.5$  cm dbh in each live and dead species class based on stems/ha (A) Stems/ha: and basal area/ha (B) Basal area/ha: at MPB monitoring sites in the Omineca area in 2016 and 2017.

**Table S2.** Average density of regeneration (stems/ha) of trees <7.5 cm dbh at all sites/treatments in the study area in 2016 and 2017.

No.	Treatment <sup>1</sup> Code <sup>2</sup>	Pine	Hybrid Spruce	Black spruce	Fir	Aspen	Willow	Alder	Total	Total (Range)
<b>98-Mile (Site 1)</b>										
1	W-W-N-N	575	267	0	0	283	33	0	1158	350-2700
2	C-W-N-N	442	50	0	0	483	50	0	1025	200-2900
3	C-S-N-N	900	0	0	0	200	67	0	1167	1000-1400
4	C-S-N-P	1867	33	0	0	300	0	0	2200	1100-3700
5	C-S-S-N	2642	17	0	0	0	0	0	2658	1650-4050
6	W-S-N-N	1292	8	0	0	83	292	0	1675	250-5350
99	No Harvest (MPB)	1217	283	42	92	167	350	492	2642	1100-5850
<b>Malaput (Site 2)</b>										
1	W-W-N-N	1300	33	0	0	0	0	0	1333	500 – 2700
6	W-S-N-N	5317	33	0	0	867	0	0	6217	3300 - 8700
7	W-S-N-P	3517	50	0	0	3133	0	0	6700	1500 - 17400
8	W-S-S-N	2467	67	0	0	717	0	0	3250	1300 - 8100
9	W-S-S-P	5850	200	0	0	14133	0	0	20183	4100-33300
<b>Phillip Lakes (Site 3)</b>										
1	W-W-N-N	9900	92	0	175	0	0	0	10167	7700-14950
2	C-W-N-N	11517	75	0	75	0	0	0	11667	6600-14150
3	C-S-N-N	4760	20	0	20	0	0	0	4800	2400-10000
4	C-S-N-P	5767	42	0	250	0	0	0	6058	3150-8500
5	C-S-S-N	8183	483	0	250	0	0	0	8917	4400-16400
6	W-S-N-N	8833	250	0	308	0	0	0	9392	4450-13050
99	No Harvest (MPB)	12183	142	0	2125	0	0	0	14450	6800-21000
<b>Laidman Lake (Site 7)</b>										
11	Prescribed burn	711	87	0	0	2056	0	0	2833	400-7500
99	No Harvest (MPB)	17610	460	0	0	0	0	0	18070	950-57800
<b>Jackfish Creek (Site 8)</b>										
99	No Harvest (MPB)	1050	167	0	100	17	0	0	1333	200 – 2100
<b>South Discovery Creek (Site 12)</b>										
99	No Harvest (MPB)	1039	64	16	65	17	297	0	1496	500-2725
<b>Discovery Creek (Site 34)</b>										
99	No Harvest (MPB)	2017	200	0	33	0	0	0	2250	500-3500
<b>Upper Osilinka (Site 48)</b>										
99	No Harvest (MPB)	400	50	0	17	0	0	0	467	100-1200

<sup>1</sup> N = 6 plots at each site/treatment except Phillip Lakes Treatment 3 where N = 5, and Laidman Lake where N = 5 at Treatment 99, and N=9 at Treatment 11. <sup>2</sup> Code 1: Harvesting method: C = cut-to-length; W = whole tree. Code 2: Harvesting season: S = summer; W = winter. Code 3: Site preparation: N = none; S = drag scarify. Code 4: Regeneration method: N = natural; P = planting

At 98-Mile (Site 1), the highest regeneration densities were found in the No Harvest treatment and treatment 5, followed by treatment 4. Treatment 5 was the only treatment that included drag scarification and treatment 4 was the only treatment that included planting. None of those three treatments were adjacent to each other. The three treatments that contained the lowest densities of regeneration (treatments 1, 2, 3) were located adjacent to each other.

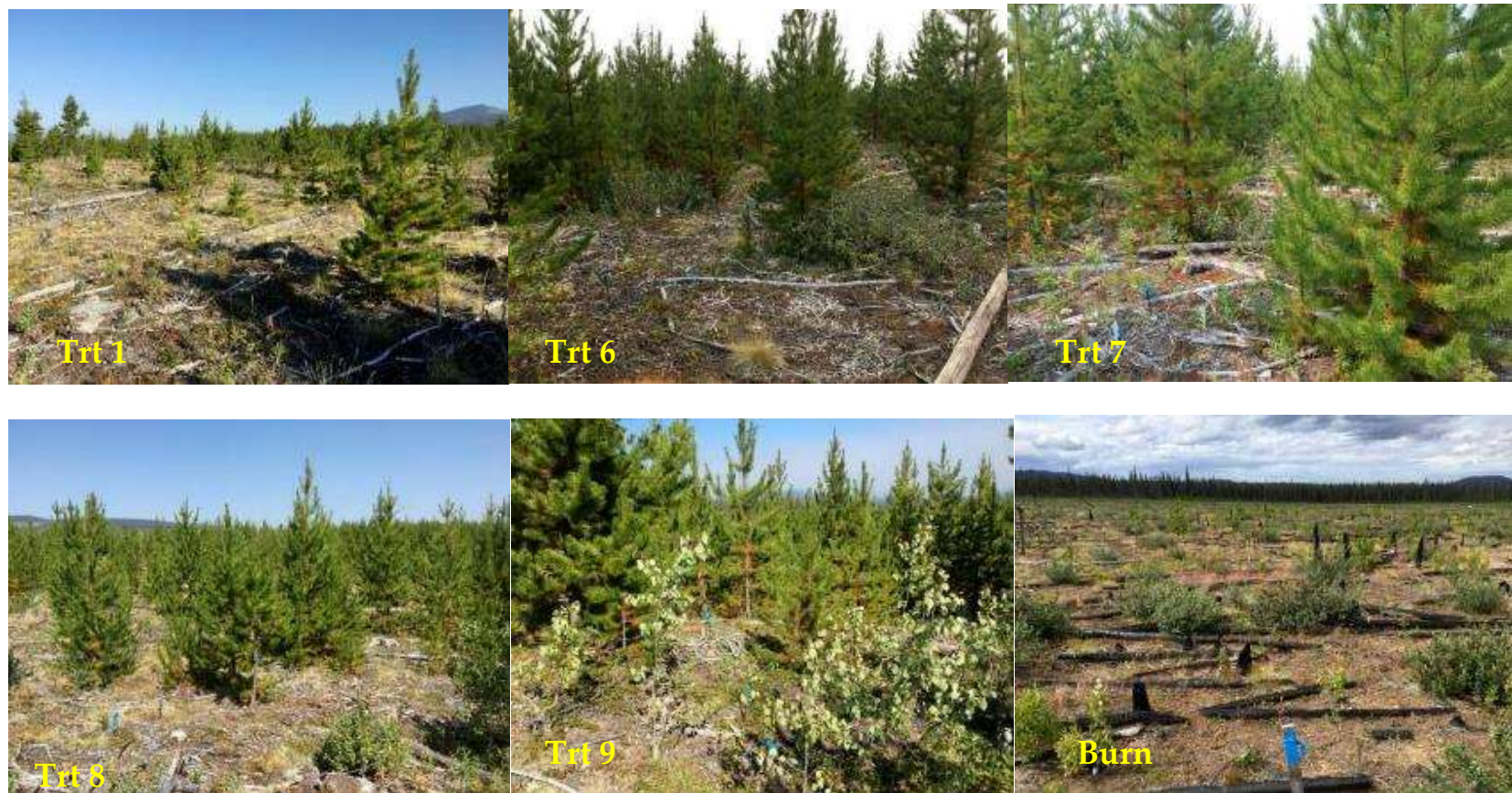
There did not appear to be any consistent trends in regeneration densities in response to treatment regime across the three adaptive management sites.

Figures S2 to S5 show examples of regeneration and stand structure at each site/treatment.



**Figure S2.** Examples of regeneration at treatments at the 98-Mile site (Site 1), 2016.





**Figure S3.** Examples of regeneration at forest harvesting treatments at the Malaput site (Site 2 – Treatments 1, 6, 7, 8, 9), and in the prescribed burn at the Laidman Lake site (Site 7 - Burn), 2017.





**Figure S4.** Examples of regeneration at treatments at the Phillip Lakes site (Site 3), 2016.



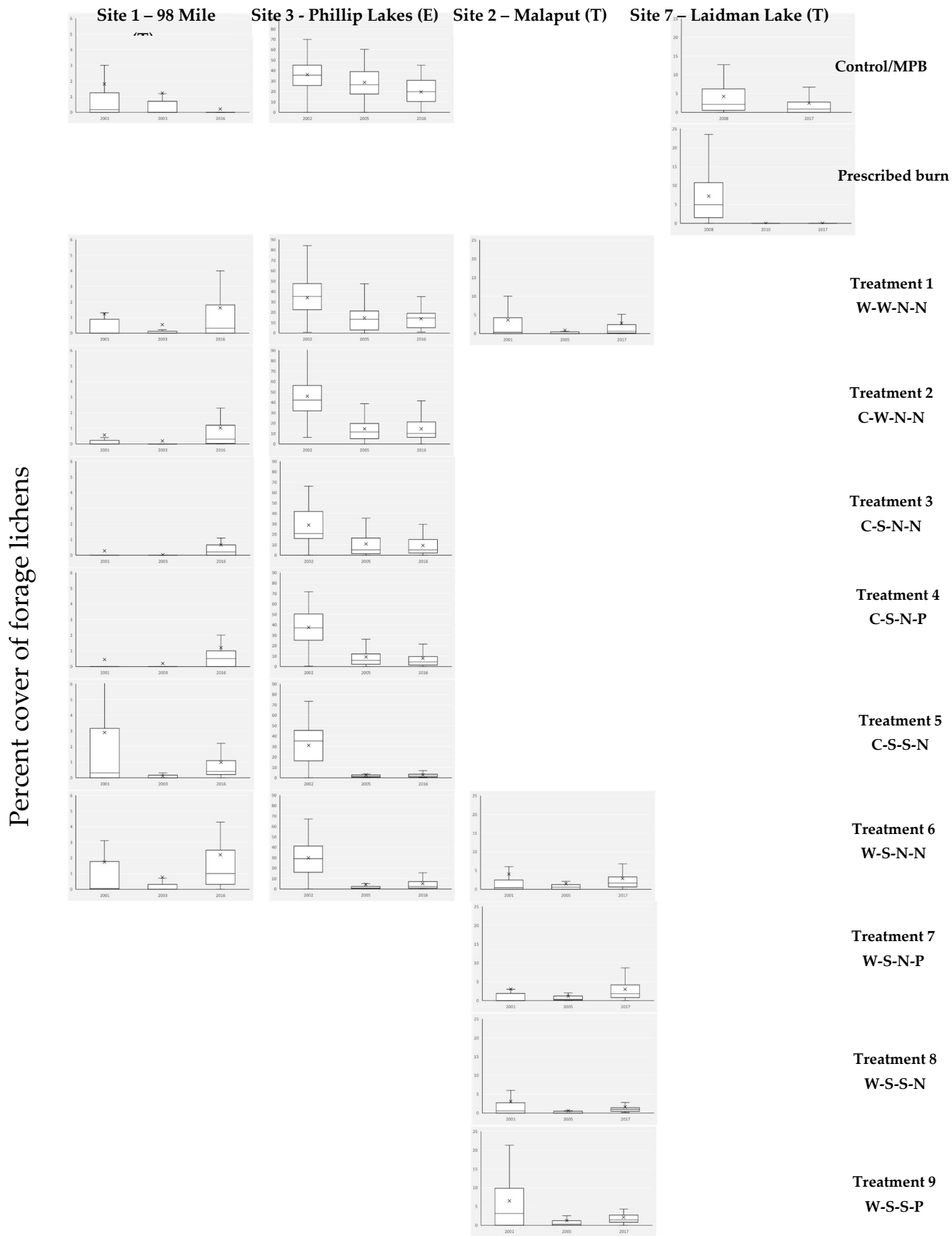


**Figure S5.** Examples of stand structure and regeneration at the MPB monitoring sites at transitional sites (top row): 98-Mile (Site 1 – No Harvest), Laidman Lake (Site 7), Jackfish Creek (Site 8), South Discovery Creek (Site 12); and at edaphic sites (bottom row): Philip Lakes (Site 3 – No Harvest), Discovery Creek (Site 34), Upper Osilinka (Site 48), in 2016 and 2017.

**Relative temporal responses of caribou terrestrial forage lichens, red-stemmed feathermoss and vascular vegetation at forest harvest treatment sites.**

Changes in abundance (% cover) of caribou terrestrial forage lichens (hereafter forage lichens), the dominant species of moss (red-stemmed feathermoss (*Pleurozium schreberi*) and all vascular vegetation (excluding trees) at each of the three adaptive management forest harvest treatment sites (98 Mile; Malaput; Phillip Lakes) are shown in the following figures (Figures S6, S7, and S8). As well, temporal responses of forage lichens to MPB are shown in Figure S9 for the 6 MPB monitoring plots. (see Methods for selection and designation of these plots).

For each of the following figures, codes for each site are E=Edaphic; T=Transitional. The data in each figure represents untransformed % cover obtained from sampled quadrats. Boxplots show the mean (X), median (central bold line), the 25–75% interquartile distribution of values (white rectangle) and the distribution of values  $\pm 1.5$  multiplied by the interquartile distance (whiskers). See Table 2 (main paper) for treatment codes.



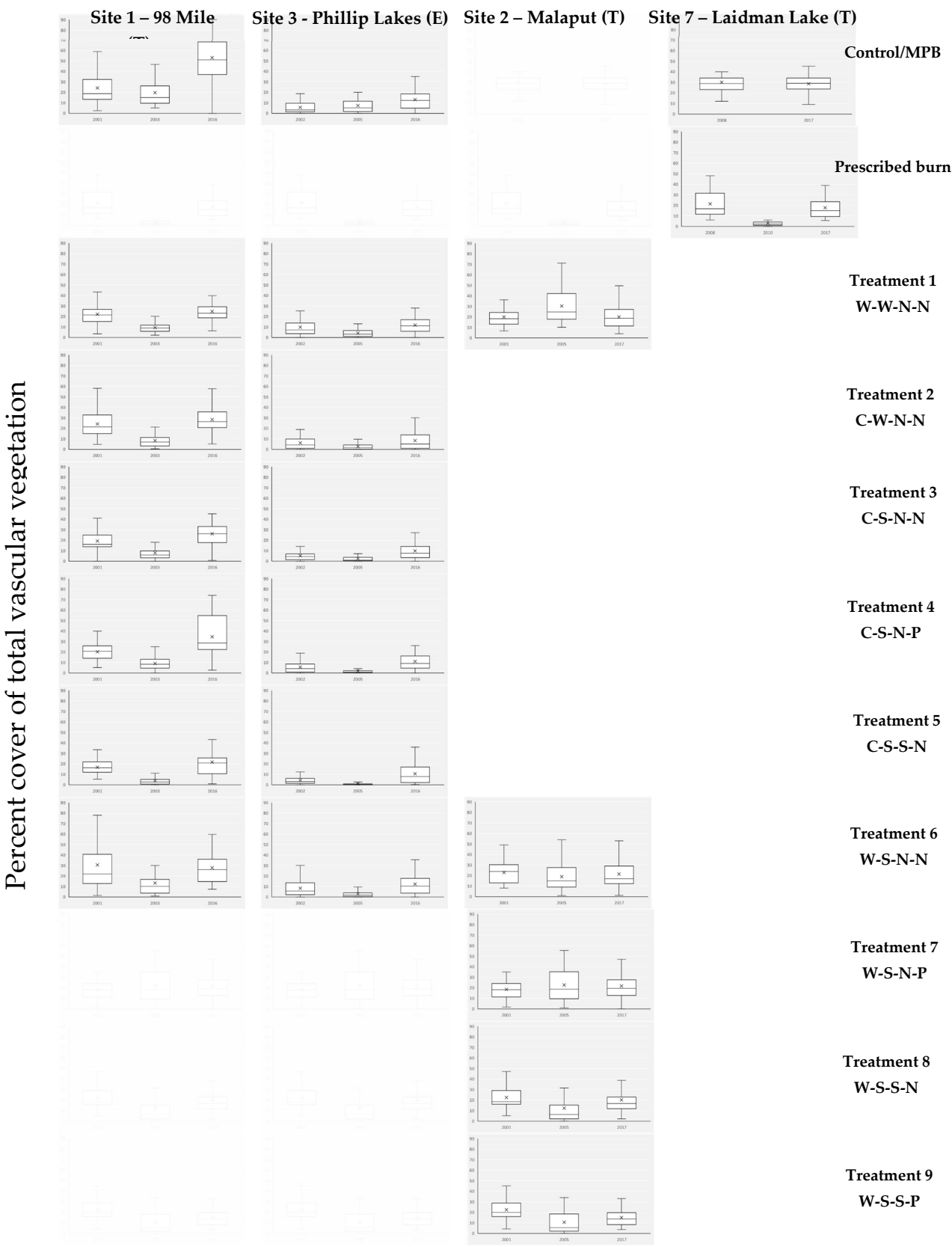
**Figure S6.** Relative temporal responses of total cover of forage lichens to forest harvesting and prescribed burn treatments (row of panels) applied at each site (column of panels) and study year (x-axis for each panel). E = Edaphic, T = Transitional successional types. See text for description of boxplots.

Percent cover of red-stemmed feathermoss (*Pleurozium schreberi*)

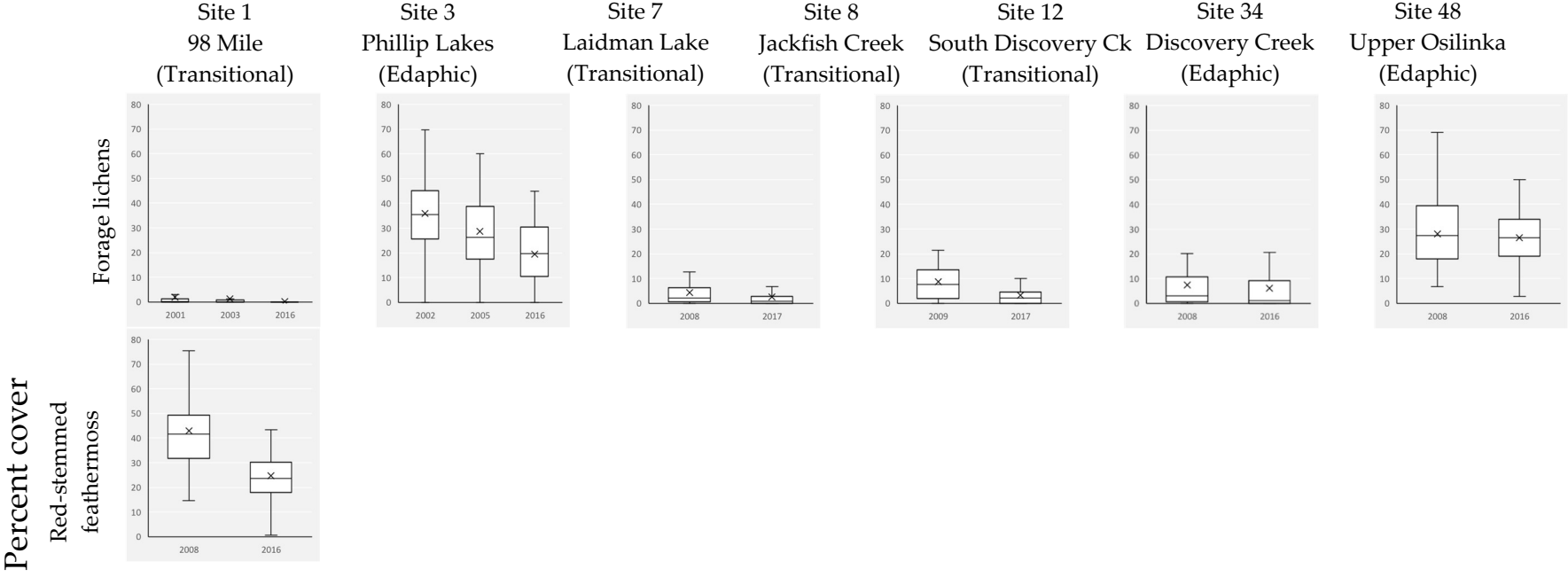


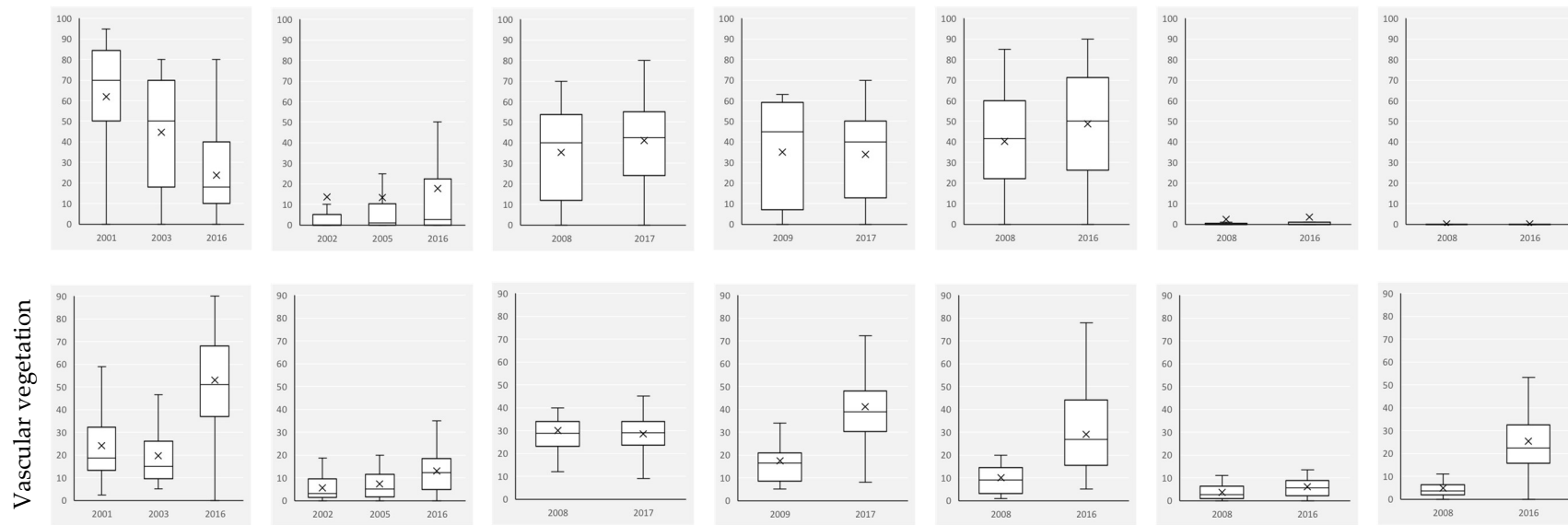
**Figure S7.** Relative temporal responses of red-stemmed feathermoss (*Pleurozium schreberi*) to forest harvesting and prescribed burn treatments (row of panels) applied at each site (column of panels). E = Edaphic, T = Transitional successional types. See text for description of boxplots.





**Figure S8.** Relative temporal responses of total vascular vegetation (excluding trees) to forest harvesting and prescribed burn treatments applied at the 98-Mile, Malaput, Phillip Lakes and Laidman Lake study sites. E = Edaphic, T = Transitional successional types. See text for description of box-plots.





**Figure S9.** Temporal responses of percent cover of forage lichens (top), red-stemmed feathermoss (middle) and vascular vegetation (bottom) to effects of the mountain pine beetle (MPB) outbreak. The x-axis shows the study years. See text for description of boxplots.

**Supporting Analyses and Results.***Description of variables used in analyses***Table S3.** Definition of variables collected in data samples and used in analyses.

Type	Variable	Unit	Scale
<i>Vegetation</i>			
	Total forage lichen <sup>1</sup>	% cover	quadrat
	Total vascular vegetation <sup>2,4</sup>	% cover	quadrat
	Total moss species <sup>3,4</sup>	% cover	quadrat
	Total debris accumulation <sup>5</sup>	% cover	quadrat
	Exposed soil	% cover	quadrat
	Density of regenerating trees (< 7.5 cm dbh)	stems/ha	treatment <sup>6</sup>
	Density of live trees (≥ 7.5 cm dbh)	stems/ha	treatment
	Total % of trees (≥ 7.5 cm dbh killed by MPB at time of sample)	%	treatment
<i>Non-Vegetation</i>			
	Organic matter disturbance	% removed	treatment
	Treatment regime (forest harvesting only) <sup>7</sup>	nominal	treatment
	Type of 1 <sup>st</sup> disturbance <sup>8</sup>	nominal	treatment
	Type of 2 <sup>nd</sup> disturbance	nominal	treatment
	Time since 1 <sup>st</sup> disturbance	years	site
	Time since 2 <sup>nd</sup> disturbance	years	site
	Successional type <sup>9</sup>	nominal	site

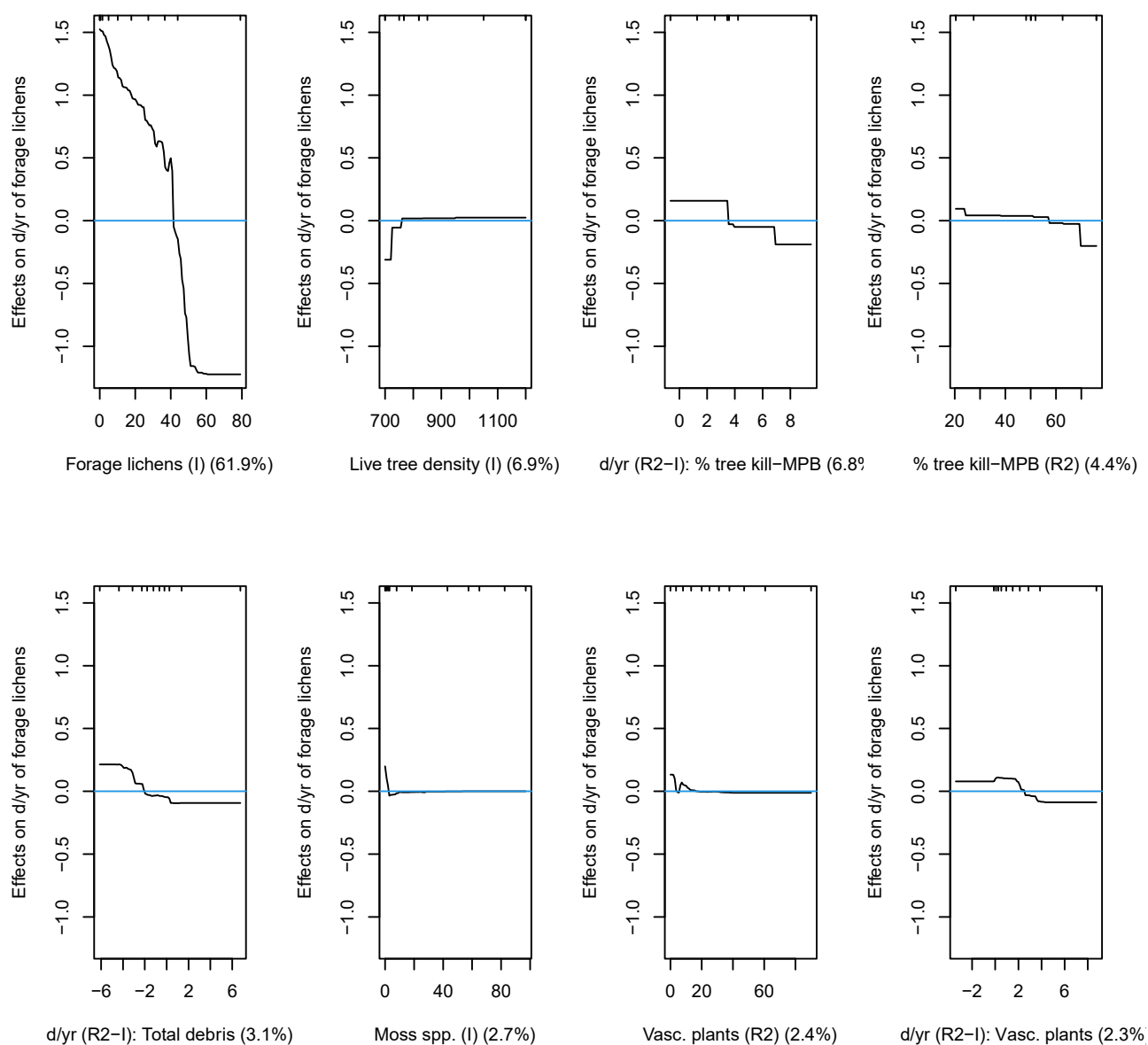
<sup>1</sup> Total forage lichens = total percent cover of *Cladonia* sp. [reindeer lichens and pixie lichens] + *Cetraria* sp. + *Stereocaulon* sp. <sup>2</sup> Total vascular vegetation = total percent cover of all species of vascular vegetation (excluding trees) in quadrat. <sup>3</sup> Total moss species = total percent cover of all moss species in quadrat including red-stemmed feathermoss (*Pleurozium schreberi*). <sup>4</sup> In analyses, Total vascular vegetation and Total moss species were also combined together into: Total vascular vegetation + Total moss spp. <sup>5</sup> Total debris accumulation = total percent cover of litter and CWD (each measured separately) in quadrat. <sup>6</sup> Data at the treatment level were sampled from plot transects (see Figure 3). <sup>7</sup> Forest harvesting treatment regimes are defined in Table 2. <sup>8</sup> Disturbances in this study are: natural = MPB; forest management = FH (forest harvesting), PB (prescribed burning). <sup>9</sup> Successional type of the site = edaphic or transitional (see Table 2).

*Factors influencing recovery rates of forage lichen abundances after disturbance***Table S4.** Most important two-way interactions between predictor variables for fitted BRT models containing all influential predictors.

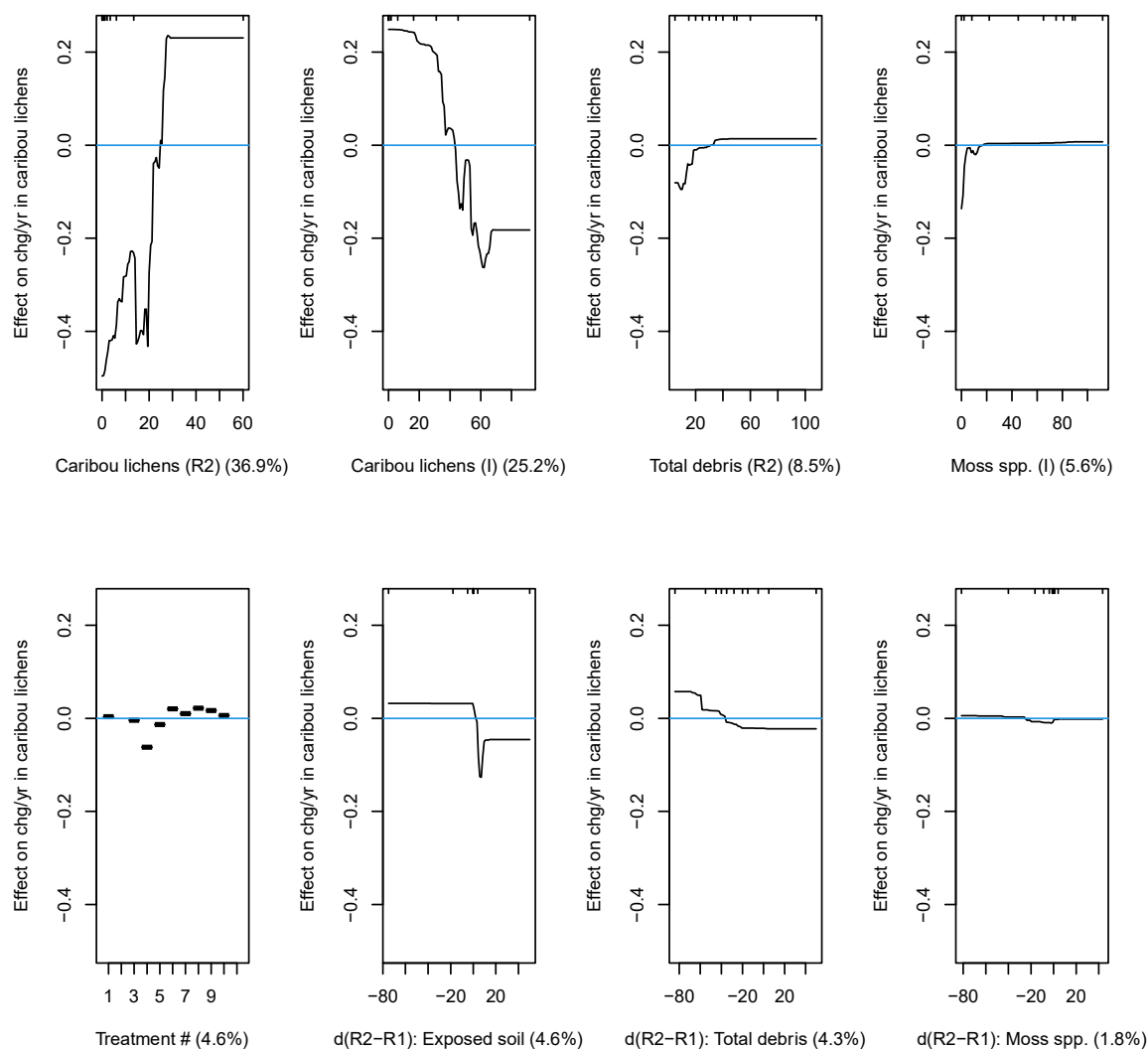
Interaction		Relative interaction strength (%) <sup>1</sup>
<b>Years since 1st disturbance</b>	<b>X</b>	Total debris cover 27.1
Successional type	X	Moss species cover 24.3
Years since 1st disturbance	X	Moss species cover 13.6
Successional type	X	Total debris cover 11.9
Moss species cover	X	Live tree density (stems/ha) 6.3
Total debris cover	X	Live tree density (stems/ha) 4.5
Successional type	X	Exposed soil cover 4.5
Successional type	X	Vascular plant cover 4.0
Successional type	X	Exposed soil cover 3.6
Vascular plant cover	X	Total debris cover 1.0

<sup>1</sup> calculated as the % of the contribution of each interaction to the sum of the deviances accounted for by the top 10 two-way interactions in the fitted trees.





**Figure S10.** Partial dependency plots assessing the effects of predictor variables on annual rates of change of forage lichens (d/yr) following MPB disturbance on five selected sites. Y-axes are the marginal effect on annual rate of change in cover of caribou lichens once the effects of all other variables are accounted for. Numbers in brackets give the relative influence of each predictor variable. Rug plots at inside top of each plot show the distribution of samples (treatments x quadrats/treatment) across the respective variable, in deciles. Abundances shown are: the initial (pre-disturbance) measurement (I); the most recent (post-disturbance) measurement (R2); and the annual rate of change in abundance since the initial measurement (d/yr [R2-I]).



**Figure S11.** Partial dependency plots assessing the effects of the predictor variables on annual rates of change of forage lichens (chg or d/yr) following forest harvest. Y-axes are the marginal effect on annual rate of change in cover of caribou lichens once the effects of all other variables are accounted for. Numbers in brackets give the relative influence of each predictor variable. Rug plots at inside top of each plot show the distribution of samples (treatments x quadrats/treatment) across the respective variable, in deciles. Abundances shown are: the initial (pre-disturbance) measurement (I); the most recent (post-disturbance) measurement (R2); and the annual rate of change in abundance since the first re-measurement (d/yr [R2-R1]).