Contents

1 Stratification

After lodgepole pines (Pinus contorta) have been attacked by Mountain Pine Beetle (MPB), they show different stages. The needles of attacked trees wil turn from green over yellow to red within the first 12 months (red-attack). It then takes in between 1-3 years until all needles have fallen to the ground, when the trees remain standing but without needles (grey-attack) [**wulderRemoteSensingSurvey2005**]. Depending on the type of stand, according to **mitchellFallRateLodgepole1998**, dead trees begin to fall after 3 to 5 years and 80 - 90 % of trees had fallen after 11 years. This leads to different stages of beetle attack that will be considered in this study. All green-attack trees detected in 2021 nad 2020 are now with high probability in the red-attack stage. Some of the trees that have been detected as red-attack in 2021, will still classify as red-attack and others as grey-attack. A clear distinction based on time of detection is not possible without additional data, since it can take several years before all needles have fallen of the tree, the GPS locations of MPB-attacked trees provided by the government of Alberta [**wulderRemoteSensingSurvey2005**]. Collecting the LiDAR data at the end of May, all green-attack trees that have been attacked in 2019 and before, as well as all red-attack trees detected in 2020 and before, will now classify as grey attack. Additionally, it can be expected that most of the trees that have been detected as red-attack in 2011 and before, now have fallen to the ground [**schoennagelEffectsMountainPine2012**].

Three broad areas of interest have been selected (refer to fig AoIs) based on availability of observed MPB attacks in the years 2011, 2019, 2020, and 2021, while also having a dense network of paved roads and gravel roads. These areas of interest will be referred to as th Grande Prairie (GP) area in the North-West, the Whitecourt (WC) area in the North-East, and the Rocky Mountain House (RMH) area to the South-East.
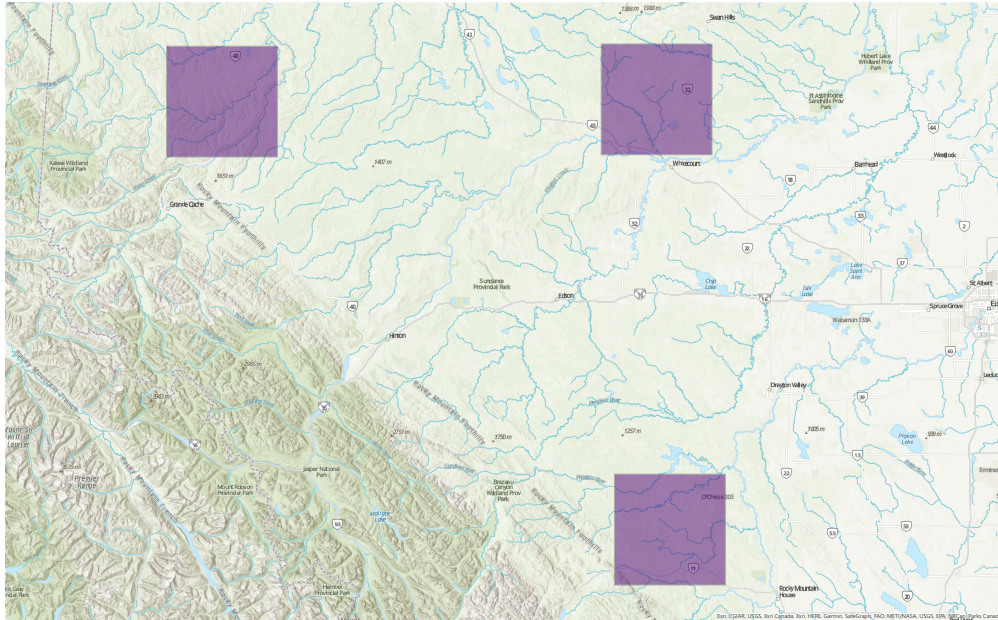

Figure 1: 50 km by 50 km areas of interest for further investigation.

As already shown by various authors before, lodgepole pine (Pinus contorta) is the most commonly attacked

Table 1: Value and NFI Code for Species Common Names

ï»¿Value Code	NFI Code	Common Species Name	Scientific Species Name
0	NO.TREE	No Trees	
2	ABIE.BAL	Balsam Fir	Abies balsamea
3	ABIE.LAS	Subalpine Fir	Abies lasiocarpa
10	BETU.PAP	White Birch	Betula papyrifera
13	LARI.LAR	Tamarack	Larix laricina
16	PICE.ENG	Engelmann Spruce	Picea engelmannii
17	PICE.GLA	White Spruce	Picea glauca
18	PICE.MAR	Black Spruce	Picea mariana
22	PINU.BAN	Jack Pine	Pinus banksiana
23	PINU.CON	Lodgepole Pine	Pinus contorta
27	POPU.BAL	Balsam Poplar	Populus balsamifera
29	POPU.TRE	Trembling Aspen	Populus tremuloides
30	PSEU.MEN	Douglas-Fir	Pseudotsuga menziesii
35	TSUG.HET	Western Hemlock	Tsuga heterophylla

by MPB, thus, areas where chosen, where lodgepole pine is one of the most dominant species. This information was based on a visual analysis of species classification, how it was in 2019, on a 30 m by 30 m grid. Each resulting pixel is classified as the most dominant tree species within that pixel. Where trees were not the dominant species, the pixel is classified as "No Tree". Table 1 shows all species that dominate the area classified within at least one pixel and their corresponding value and NFI codes.

The government of Alberta conducts annual Heli-GPS surveys, usually between August 15 and September 15 by flying helicopters at low hight and mapping the GPS locations of detected disturbances in therms of red- and green-attack through observers. These locations have a positional accuracy of +/- 30 m. In most cases only patches consisting of at least 3 trees are recorded. For each of these locations the corresponding cell from the raster data containing the tree species is determined and with a box filter of 5 by 5 the most common tree species for each point can be determined. An example for these buffered GPS locations and the corresponding species data is shown in fig. 2. This analysis is performed for each of the three areas of interest, both in absolute numbers of pixels within each kernel and relative to the total number of included pixels for each year. It is possible that an area surrounding a GPS location only consists of pixels that have been classified as "No Tree". This only means that, in 2019 when the data had been collected, the corresponding 30 by 30 m cell was not predominantlyS covered by trees.

Information on accessibility is based on the road network available through the government of Alberta [**GravelRoad2021**, **PavedRoad2021**], since all flight locations with the drone need to be accessible from the road for efficient data collection. As the drone has to stay in line of sight, it is not possible to fly far away from the road.

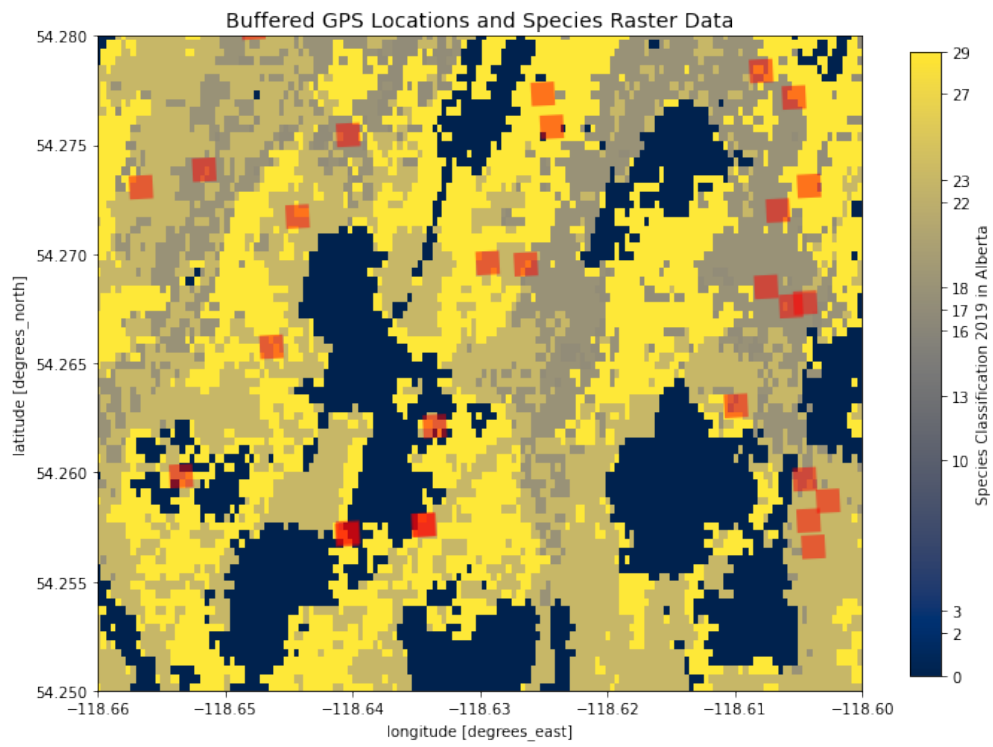This document was written with bookdown [**R-bookdown**].

2 References

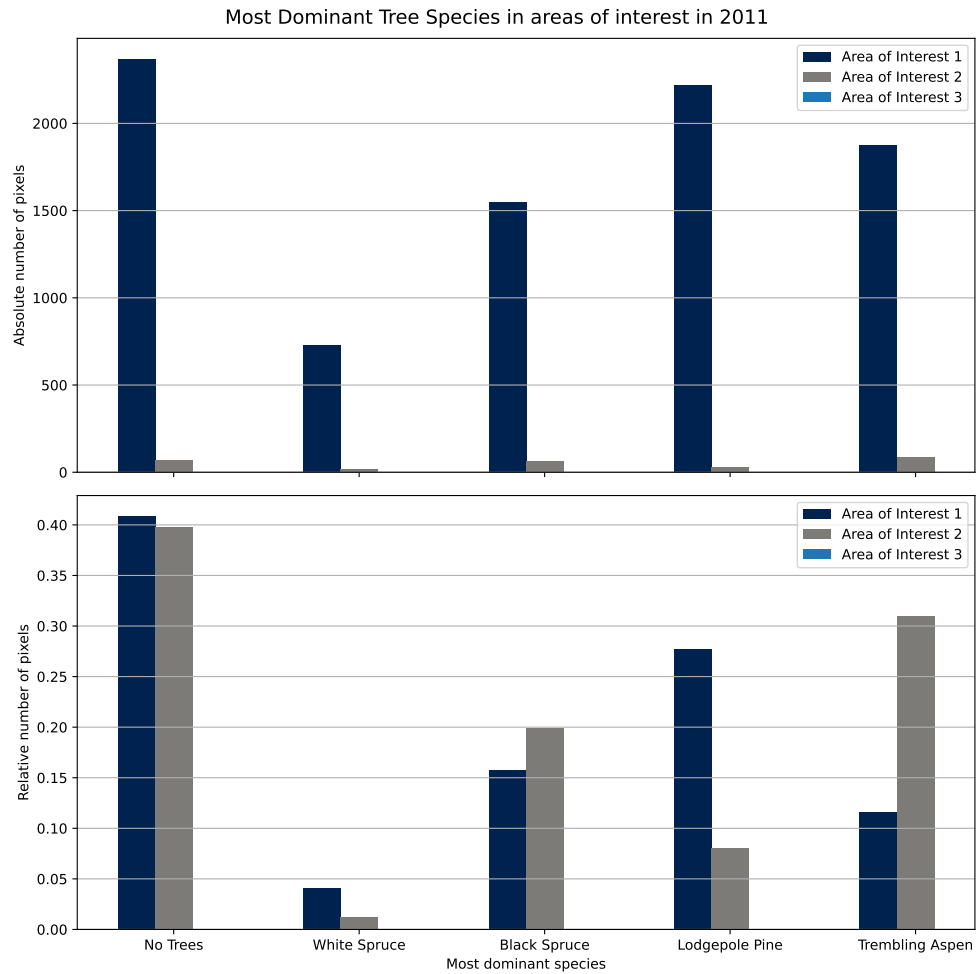Figure 2: Exemplary buffered GPS locations

Figure 3: Frequency of tree species within the surrounding area of each MPB survey point for the year 2011.
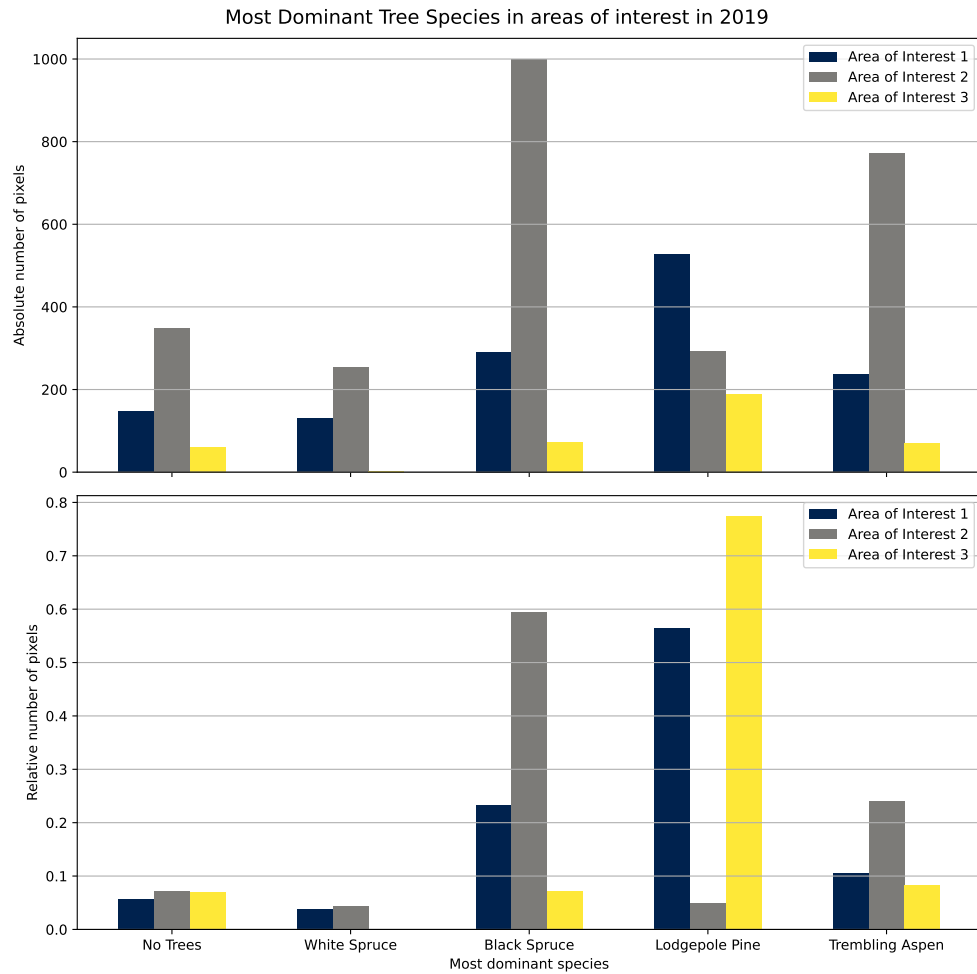
Figure 4: Frequency of tree species within the surrounding area of each MPB survey point for the year 2011.
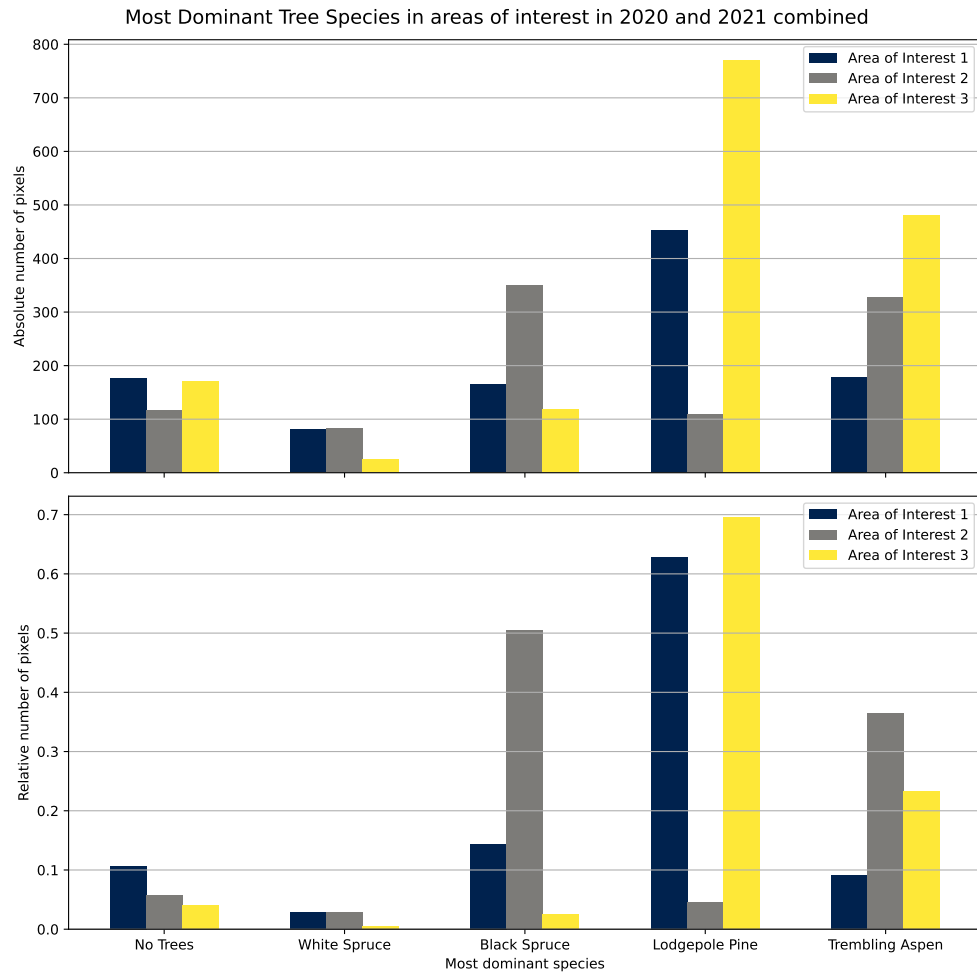
Figure 5: Frequency of tree species within the surrounding area of each MPB survey point for the year 2011.