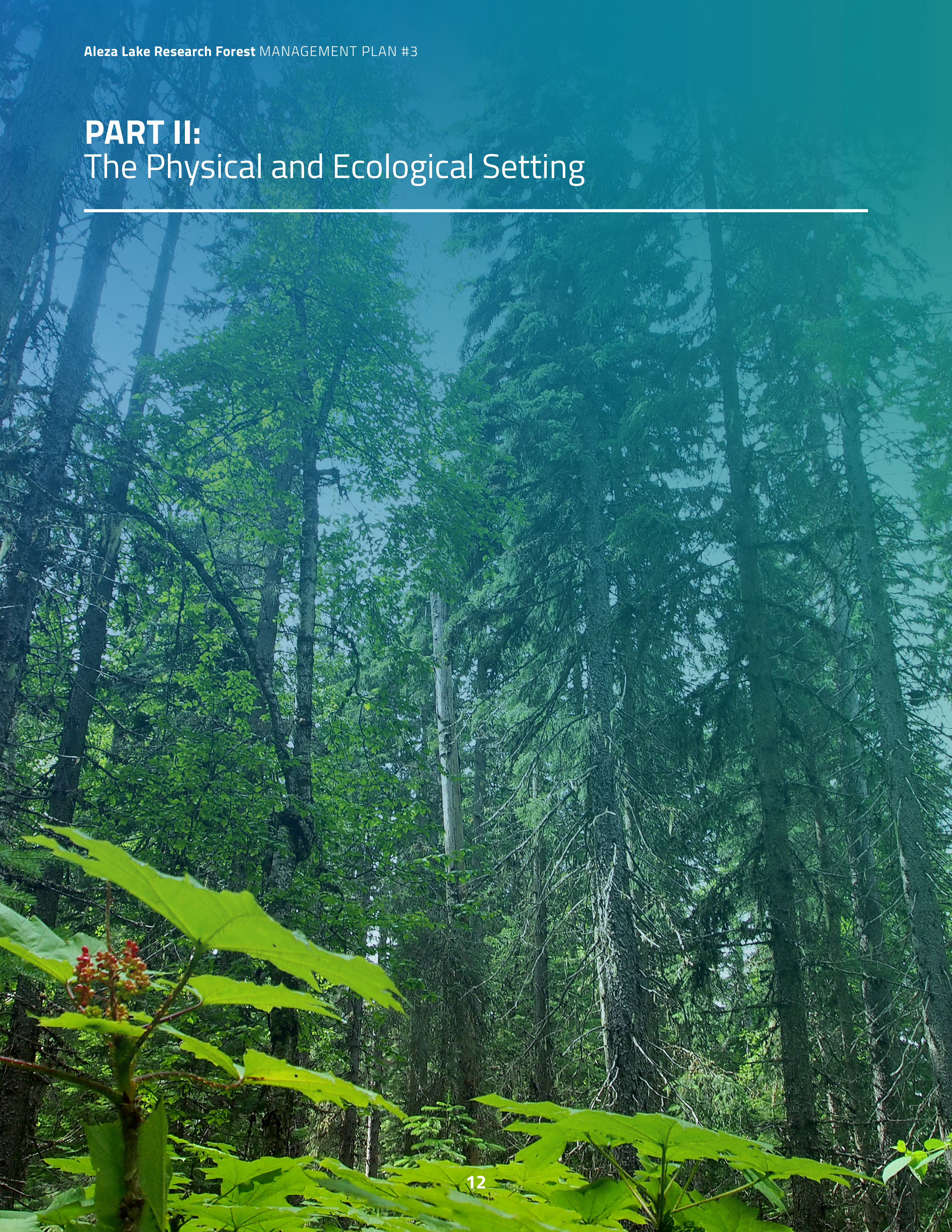
PART II: The Physical and Ecological Setting



4. ALRF PHYSICAL GEOGRAPHY & ECOLOGY

4.1 Climate

The Aleza Lake Research Forest is located in the Willow River Wet Cool Sub-boreal Spruce (SBSwk1) biogeoclimatic zone (DeLong, 2003). The SBSwk1 is characterized by cold, snowy winters, moist cool summers, and moderately heavy snowpack accumulations in the winter months. The continental nature of the climate is also influenced by relatively mild and moist Pacific air masses. Some ALRF ecosystems show floristic similarities and ecological characteristics transitional to the nearby Interior Cedar-Hemlock biogeoclimatic zone (i.e. – the Wet Trench Very Wet Cool ICHvk2 subzone).

The ALRF lies on the eastern edge of the Central Interior plateau, within 20km of the McGregor Range and the western slopes of the Rocky Mountains. It is likewise just 10km north of the northern Cariboo (or Columbia) Mountains. Due to its windward proximity to these mountain ranges, the ALRF receives substantially higher levels of both rainfall and snowfall compared to more central areas of the plateau. For example, the ALRF receives about 45 to 50% greater rain and snow than Prince George BC, on average.

A comparison of historical climatic normals for the ALRF and Prince George weather stations are provided in Table 1. These data, of course, describe averages of past climatic conditions to date for these two locations. Additionally, a report by Foord (2016) provides information and data on broader regional climatic patterns and trends for the Omineca and other BC northern forest regions, as well as climatic projections for these regions under the influence of anthropogenic climate change.

Table 1: Comparison of Historical Climate Normals: Prince George and Aleza Lake BC

Parameter	PG(A)*	ALRF AES**	ALRF A1 ***
Precipitation (Rainfall and Snowfall)			
Mean Annual Precipitation (mm)	615.	895.	Data Not Available
Mean Annual Rainfall (mm)	415.	556.	
Mean Annual Snowfall (cm)	234.	343.	
Maximum 1-Day Precipitation (mm)	38.9	57.2	
Maximum 1-Day Rainfall (mm)	38.9	55.9	
Maximum 1-Day Snowfall (cm)	30.8	49.3	

Parameter	PG(A)*	ALRF AES**	ALRF A1 ***
Temperature Regime			
Mean Annual Temperature (C°)	3.7	3.1	4.0
Extreme Coldest Temperature (C°)	- 50.0	- 46.7	- 40.9
Extreme Hottest Temperature (C°)	36.0	36.0	34.1
Mean Annual Days with Minimum Temp. > 0 degrees C (at screen height 1.5 m)	179.	156.	167.
Mean Growing Degree Days > 5 C	1284.	1173.	1232.

* Prince George "A" Station, AES, 1970 to 2000 ** Aleza Lake AES, 1952 to 1980 *** Aleza Lake A1 Climate Station, 1993-2016

4.2 Geology, landforms, and soils

4.2.1 Physiography

The ALRF is situated on the McGregor Plateau of the Fraser Basin in the Interior Plateau physiographic region, within the Nechako Plain portion of the Interior Plateau (Holland, 1976). The Interior Plateau is generally typified by undulating to moderately rolling and hilly terrain.

4.2.2 Bedrock Geology

Bedrock geology within the ALRF consists predominantly of rock strata from the Wolverine Metamorphic Complex and Wolverine Range Plutonic Suite (Struik 1989, Struik and Fuller 1988). These generally igneous rocks are granodioritic plutons, rhyolites, and granites. Smaller amounts of pillow basalts, breccia, phyllite, and minor micritic limestone may potentially outcrop in parts of the study area (Struik et al. 1990).

Recent geological mapping from GeoScience BC (2009) indicates that two main intrusive igneous bedrock types occur in the vicinity of the ALRF. These are granodiorites of Cretaceous to Tertiary origin, and quartz monzodiorites of early Tertiary origin. These bedrock types are often overlain by deep Quaternary deposits of glacio-lacustrine (post-glacial lake-bottom) sediments, glaciofluvial sands, and some areas of till and glacial drift.

4.2.3 Holocene (post-glacial) history and resultant landforms

The predominant landforms in the ALRF area are glaciolacustrine or fluvial in origin, dating from the post-glacial melt period, approximately 9,000 to 10,000 years before present. Regional studies of surficial geology indicate that the relatively low-lying Upper Fraser basin including the present-day ALRF was occupied by a large glacial lake basin (or a series of lake basins) during the late glacial period (Tipper 1971). Higher bedrock outcrops on the ALRF were islands in this large lake. Prevailing evidence suggests that lake levels remained stationary for periods of time, creating beaches and shoals composed of rounded sands, gravel and stone deposits in some areas of the ALRF. These include old lakeshore deposits found in the central, southern, and eastern portions of the ALRF at elevations between 685 to 710 metres ASL (Oikos, 1994).

Forest vegetation growing over fractured bedrock and colluvial veneer soils near the West Bear Road, ALRF

When the post-glacial lake(s) drained (often in abrupt drainage events as glacial ice dams shifted or gave way), rapidly-outflowing lake waters incised and eroded the lake-bottom sediments of the draining glacial lake, establishing drainage patterns in the newly-exposed land surface. Numerous ravines have been cut by natural erosional processes over millenia into the soft glaciolacustrine sediments. The elevation and location of underlying bedrock formations between the elevations of 680 to 750 metres a.s.l ultimately controlled the depth of erosional processes, and determined the location of a major watershed divide on the ALRF between the Hansard Creek watershed to the north, and the Bowron River watershed to the south.

During the post-glacial period and up to the present, the Bowron River cut down into glaciofluvial deposits along the southern boundary of the ALRF, and also formed new fluvial deposits. The Bowron River also contributes new sediments deposited from its upper watershed, and has created a broad and very active floodplain with highly mobile stream channels and a complex micro-topography produced by ongoing lateral cutting and overbank deposition. The variable Bowron floodplain landscape is composed of floodplain deposits formed at different heights above the river, influenced and modified by ongoing alluvial processes. These create many sand and gravel bars at various successional stages, and extensive wetlands in old oxbows, back-channels, and inter-levee depressions, and provide rich and varied wildlife and aquatic habitats.

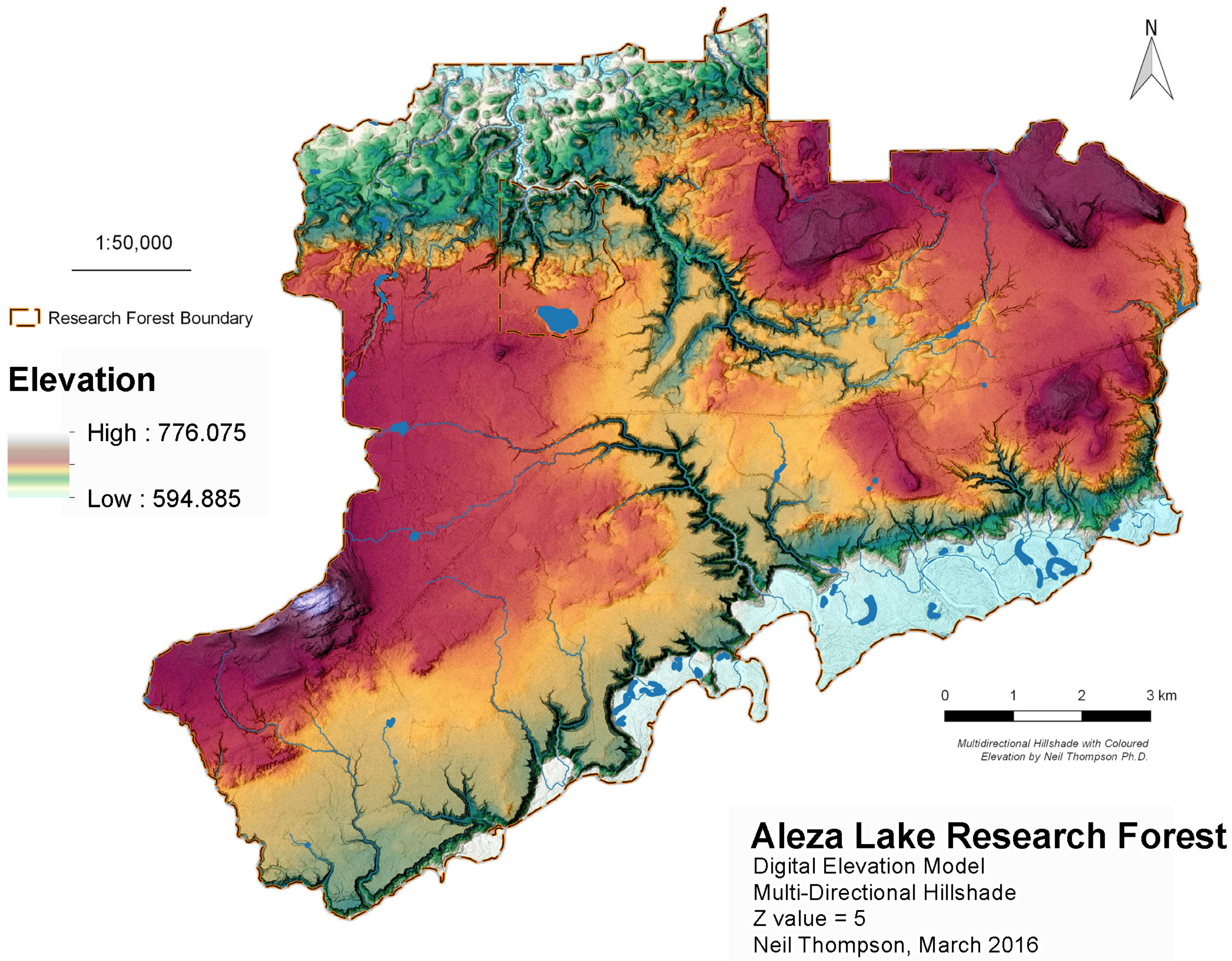


Figure 2: Digital elevation model for the Aleza Lake Research Forest

Digital elevation model for the Aleza Lake Research Forest and environs, highlighting elevational zones and landforms based on 2015 LiDAR imagery (courtesy of Dr. Neil Thompson, UNBC). Elevations are noted in metres above sea level (a.s.l.).

4.2.4 Landslide and mass-movement processes

The process of gradual natural erosion into the deep, fine-textured glaciolacustrine (lake-bottom) sediments accumulated in the post-glacial period in the upper Fraser Basin, and incising of deep, dendritic ravine systems, continues to this day. Despite thick forest cover within many drainage systems, mass movements including rotational failures and localized slipping / slumping of sediments do periodically occur in gullied ALRF areas with fine-textured sediments, steep ravine side-walls, and heavy seasonal run-off.

The proximity of such sensitive features and geomorphic processes, frequently near or to adjacent to high riparian, aquatic, and fisheries values in associated streams, makes the careful management of ravines and other area sensitive slopes a high priority for management activities within the ALRF landbase.

4.2.5 Soils and soil types

Across the rolling upland and plateau portions of the ALRF, finer-textured silt, clay, and sandy soils predominate, with some organic soils interpersed. Silty-clay lacustrine soils are most common; these soil types are mainly Luvisols, including Podzolic Gray Luvisols in relatively well drained areas, and Gleyed Orthic Gray Luvisols in more poorly-drained, level areas with higher clay content (Dawson 1989). On sandy soils, Brunisols, and occasionally, Podzols, are typical soil types and can provide some of the most productive sites in the ALRF. Moderate 10 to 100 cm layers or "caps" of loamy sands occurring over fine-textured glaciolacustrine deposits are more common than deeper sand deposits. Organic soils are not uncommon in the ALRF, and form in level to depressional landscape positions with impeded drainage.

On the bedrock outcrops in the study area, soils are generally derived from bedrock weathering, fracturing, and colluvial processes, and tend to be thinner, with high coarse fragment content.

In valley bottoms and ravines with active streams, soils are generally water-deposited (fluvial) sands and silts of recent origin. On such sites and on the floodplain of the Bowron River, younger Regosolic soils predominate. Organic soils and Gleysols are common in wetland areas of the floodplain with high water tables.

4.3 Forests and related vegetation

The ALRF includes rolling hills, gentle plateau, river floodplain, bedrock outcrops, and a range of terrain and forest types. These include forests of upland sub-boreal hybrid white spruce *(P. glauca x engelmannii)* and subalpine fir *(Abies lasiocarpa)*, deciduous and mixedwood forests, black spruce, and forested and non-forested wetland and semi-wetland plant communities. Other conifers occurring sporadically include Douglas-fir *(Pseudotsuga menziesii)*, western hemlock *(Tsuga heterophylla)*, and lodgepole pine *(Pinus contorta var. latifolia)*. Common deciduous tree species include paper birch *(Betula papyrifera)*, trembling aspen *(Populus tremuloides)*, and black cottonwood *(Populus trichocarpa)*.

On upland sites, mature and old-growth stands in the ALRF are typically dominated by mature mixed stands of hybrid white spruce and subalpine fir, with paper birch occurring as a minor component. At the ALRF, scattered mature and immature individuals and groups of Douglas-fir also occur on drier upland sites, ridges, and interestingly, commonly on some raised sites close to wetland margins.

Mature spruce-subalpine fir stands at the ALRF are generally two-aged to multi-aged. Within the ALRF, the lifespan of the

A large hybrid white spruce (*Picea glauca* X *engelmannii*) dominates the upper canopy of an older ALRF stand

The lower Bowron River along the ALRF's southern boundary

Large Douglas fir on a dry hilltop site at the ALRF

spruce is commonly 150 to 200 years of age, while the more numerous but shorter-lived subalpine fir (also sometimes referred to as 'balsam') is generally 100 to 160 years at maturity. Douglas-fir veterans scattered through the forest reach three to four centuries in age, ALRF staff have documented Douglas-fir that are 375 to 400 years of age.

On sites within the Bowron River floodplain in the south of the research forest, seasonal floods and associated erosional and depositional processes tend to drive the natural disturbance and distribution of floodplain landscapes. The Bowron floodplain is a complex mosaic of alluvial sites, stands, and habitats, including old river channels, alluvial wetlands, raised terraces, and gravel and sand-bars at many different ages and stages of succession. Black cottonwood is a large iconic and common seral tree species on the alluvial floodplains of the Bowron River. Areas of later-successional spruce on raised floodplain sites tend to be extensively interlaced with deciduous, mixed-wood, shrub, and wetland communities. These are rich and diverse wildlife and plant habitats.

The climate of the ALRF and surrounding McGregor Plateau is generally substantially cooler and wetter than the drier Central Interior plateau to the west. In BC's drier western Interior plateau, large stand-replacing fires and even-aged lodgepole pine forests predominate. However, in the valleys and plateau of east-central BC typical of the ALRF, fire tends to be comparatively rare. Natural disturbances in these wetbelt forests are influenced far more by gap and small-patch disturbance dynamics, with bark beetles, tree falls, and stem rots being the main drivers of spruce-balsam stand development (Lewis and Lindgren, 1999, Lewis and Lindgren, 2002, Newbery et al, 2007). Such spruce-balsam stand dynamics result in variable stand structure with a wide range of tree sizes. After gap or overstory mortality, the younger co-dominant and smaller tree layers of spruce and subalpine fir (or secondary structure) respond positively to overstory mortality and gaps through growth release (Zhanga et al, 1999).

Despite the moist to wet climate of the ALRF, there is evidence of rare but significant historical wildfires on the ALRF and in the surrounding area, with an estimated average fire return interval of perhaps 300 years or more at the stand level. The presence of old fire-seral lodgepole pine snags, scattered mature live pines in some stands, and the occasional occurrence of charcoal in the upper soil horizons of these sites provide evidence of past natural forest fires within the ALRF landbase. Lightning strikes and small fires are sometimes observed on the ALRF during summer convective storms. For example, a recent small lightning-caused wildfire occurred in the east-central ALRF in May 2010. In addition, a number of lightening-scarred trees have been observed over the years on other ALRF locations as well.

A variety of seral stages from early seral to old-growth forests are represented within the ALRF landscape. Younger seral stages on upland sites tend to dominantly influenced by historical forest harvesting and silvicultural practices. Younger natural fire-origin stands occur, but have been historically relatively rare within the ALRF.

In burned areas or clearcut areas, trembling aspen, cottonwood, and paper birch establish as vigorous natural regeneration, and form a minor component of the resultant seral stands. These tree species are occasionally present as scattered individual trees in older upland stands > 140 years of age. Similarly, lodgepole pine does naturally occur on sporadic upland sites within the ALRF. Pine has been historically planted on a number of harvested upland sites at the ALRF.

Naturally-occurring black spruce *(Picea mariana)* and lodgepole pine are generally confined to areas of restricted drainage and peaty soils where heavy clay soils, depressional locations, and perched water tables and organic deposits restrict the establishment of other tree species. However, black spruce does grow to sizes similar to hybrid white spruce in upland areas on well-drained soils near wetland margins.

Western hemlock *(Tsuga heterophylla)* in most ALRF forest types usually occurs as scattered individuals throughout upland coniferous types, although usually as smaller saplings, poles, and low co-dominant trees. On some elevated sites in the ALRF, it does form leading stands of mature hemlock mixed with minor other tree species.

Western redcedar *(Thuja plicata)* naturally occurs rarely in several very localized areas on the Aleza Lake Research Forest, primarily in the south half of the research forest closer to the ICHvk2 subzone. Plantings of cedar at the ALRF have experienced fair to moderate success on the right sites at the ALRF to date.




(LEFT) Skunk cabbage (*Lysichiton americanus*) (CENTER) Amanita mushroom (*Amanita muscaria*) (TOP RIGHT) Lady fern *(Athyrium filix-femina*) fronds (BOTTOM RIGHT) Devil's Club (*Oplopanax horridus*) on an ALRF seepage site

Introduced (planted) BC tree species within the ALRF (often in research trials or operational planting trials) include tamarack *(Larix laricina)*, planted on sites within the ALRF similar to those where black spruce occurs, western white pine *(Pinus monticola),* and western larch *(Larix occidentalis).*

The occurrence and distribution of understory plants vary with ecological conditions and seral stage on the ALRF. A preliminary plant species list for the ALRF adapted from Oikos (1995) and related sources is provided in Appendix C1. Recent research by Botting and Fredeen (2006a) and Campbell et al (2010) has also produced a preliminary list of epiphytic plants (lichens, liverworts and bryophytes) that occur on the ALRF. The ecology of two species of a sundew (*Drosera* spp.), a notable bog-dwelling insectivorous plant endemic to the ALRF has been described by Jones et al (2015).

Provincial sources also provide lists of plant species at risk in the Prince George area (BC Conservation Data Centre (CDC), 2013 in Appendix C4). This list comprises species whose range may overlap with the ALRF but whose presence in the Research Forest is not confirmed.

4.4 Hydrology and watercourses

The ALRF is located in the upper Fraser River watershed. Natural drainage patterns on the ALRF are divided by a height-of-land running roughly east-west across the middle of the Forest. In 2017, a LiDAR-derived digital elevation model was used to systematically map the watershed drainage basins within in the ALRF tenure area, based on landscape morphology and terrain (Appendix A1).

As seen in Appendix A1, the northern half of the ALRF drains in a generally northeasterly direction, into the watershed of Aleza and Hansard Lake and tributaries, while the southern drainage basins in the Research Forest flow southward into the Bowron River. Most small creeks and sub-basins within the ALRF (other than Hansard and Slaney Creeks) lack legally-gazetted names.

Hansard Creek (also known locally as Camp Creek) flows into Aleza Lake north of the Research Forest. Hansard Creek is the largest single watershed and year-round stream within the Research Forest. With the exception of Slaney Creek, most streams and drainages in the north half of the ALRF are tributary to the main stem of Hansard Creek. Two sizable lakes and numerous small swamps and wetlands feed Hansard Creek, including the 12 hectare Loup Lake (DWB Consulting Services Ltd, 2006a) in Ecological Reserve #84, and a similar-sized large lake (locally known as Tricks Lake) in the upper Hansard watershed on the northeastern perimeter of the Research Forest. The main stem of Hansard Creek has a well-developed floodplain, especially in its lower reaches, and has substantial fish populations especially rainbow trout (DWB Consulting Services Ltd, 2006b). Juvenile chinook salmon have been captured and observed in Hansard Creek reaches within the central ALRF (Environmental Dynamics, 2002, DWB Consulting Services Ltd, 2006), indicating this stream is also used by chinook as rearing habitat.

Bowron River and floodplain black cottonwood stand within the ALRF

Slaney Creek is a small perennial stream flowing through the north central part of the Research Forest and directly into Aleza Lake near the old Ranger Station site. Flow in this creek is modest due to the relatively small watershed area, but provides cooler stream temperatures due to inputs from underground springs (Kanester, 2016). Slaney Creek provides habitat for a documented small resident population of rainbow trout (Environmental Dynamics, 2002).

The southern boundary of the ALRF encompasses approximately 10 to 12 linear kilometres of the Bowron River and associated floodplain. A Water Survey of Canada gauging station along the Bowron River in the southwestern portion of the Research Forest has a continuous year-round record of river flows since 1977.

Numerous streams traverse ravines in the southern half of the ALRF, and are tributary to the Bowron River. Many are important fish habitat, especially in their lower reaches closer to the Bowron floodplain. These streams are fed by the numerous bogs, swamps, wetlands, and some springs found throughout this drainage area. Other than beaver ponds, no significant perennial lakes are found within these southern ALRF sub-basins. Numerous other smaller, primarily ephemeral drainages also dissect the area. Of these, two of the most substantial are "Boundary Creek" (local ALRF name), which forms the southeastern boundary of the Research Forest, and "Central Ravine Creek" (local name), which drains the plateau in the west-central portion of the Research Forest. Boundary Creek in particular is known to have significant fish populations (DWB Consulting Services Ltd, 2006).