PROVINCE OF BRITISH COLUMBIA

2017 Ecosystem Restoration Monitoring: Columbia Lake Site Establishment

Rocky Mountain Trench Ecosystem Restoration Program

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Introduction

The dry climatic zones of British Columbia were historically characterized by low intensity frequent fires, resulting in fire-tolerant species with minimal surface fuels (Klenner et al. 2008, Gayton 2001, Dawson 1998). A mosaic of multi-aged stands, mixed grassland and shrublands, and open forests are the result of a combination of low intensity frequent fires (every 7-50 years) as well as infrequent stand replacing fires (Kaye et al. 1999, Cooper 1960).

Open forest and grassland areas are highly susceptible to increases in conifer regeneration and encroachment resulting in loss of habitat due to canopy closure. Closed canopies reduce the amount of light that penetrates to the forest floor and encourages growth of plants that require mesic conditions in stands that historically supported sun-loving plants (Cooper 1960, Lunan and Habek 1973, and Lieffers and Stadt 1993). Increased effectiveness of wildfire management is thought to be a major contributor to the changes in forest and litter cover and conifer encroachment on low-elevation grasslands; this variation has a negative impact on wildlife habitat and the biomass production of the understory vegetation (Stam et al, 2008).

The Rocky Mountain Trench Ecosystem Restoration Program is collaborative partnerships working to restore grasslands and open Douglas fir and Ponderosa pine forests of the East Kootenay and Upper Columbia Valley Region. The program partners include an array of resource users, land managers, government agencies, First Nations, land conservation trusts, naturalist and environmental societies and other citizen stakeholder groups. These stakeholders have adopted ecosystem restoration or habitat enhancement programs intended to restore the ecological processes of fire-maintained ecosystems (Rocky Mountain Trench Ecosystem Restoration). The focus of the restoration and enhancement activities is to restore key wildlife winter range, red- and blue-listed species habitat and increase forage for livestock, thus diminishing the wildlife/livestock conflict (Rocky Mountain Trench Ecosystem Restoration Steering Committee 2006).

This report summarizes the ecosystem monitoring data collected at Columbia Lake in 2017.

Study Area

The Columbia Lake treatment unit is located on the eastern side of Columbia Lake; approximately 8 kilometers north of Canal Flats, B.C. within the East Side Columbia Lake Wildlife Management Area. The elevation varies between 900 and 1300 metres with western facing steep slopes with occasional gullies. Columbia Lake is located within the IDFdm2 biogeoclimatic zone (Interior Douglas fir dry mild) but has been recently reclassified as IDFxk (Interior Douglas fir very dry cool).

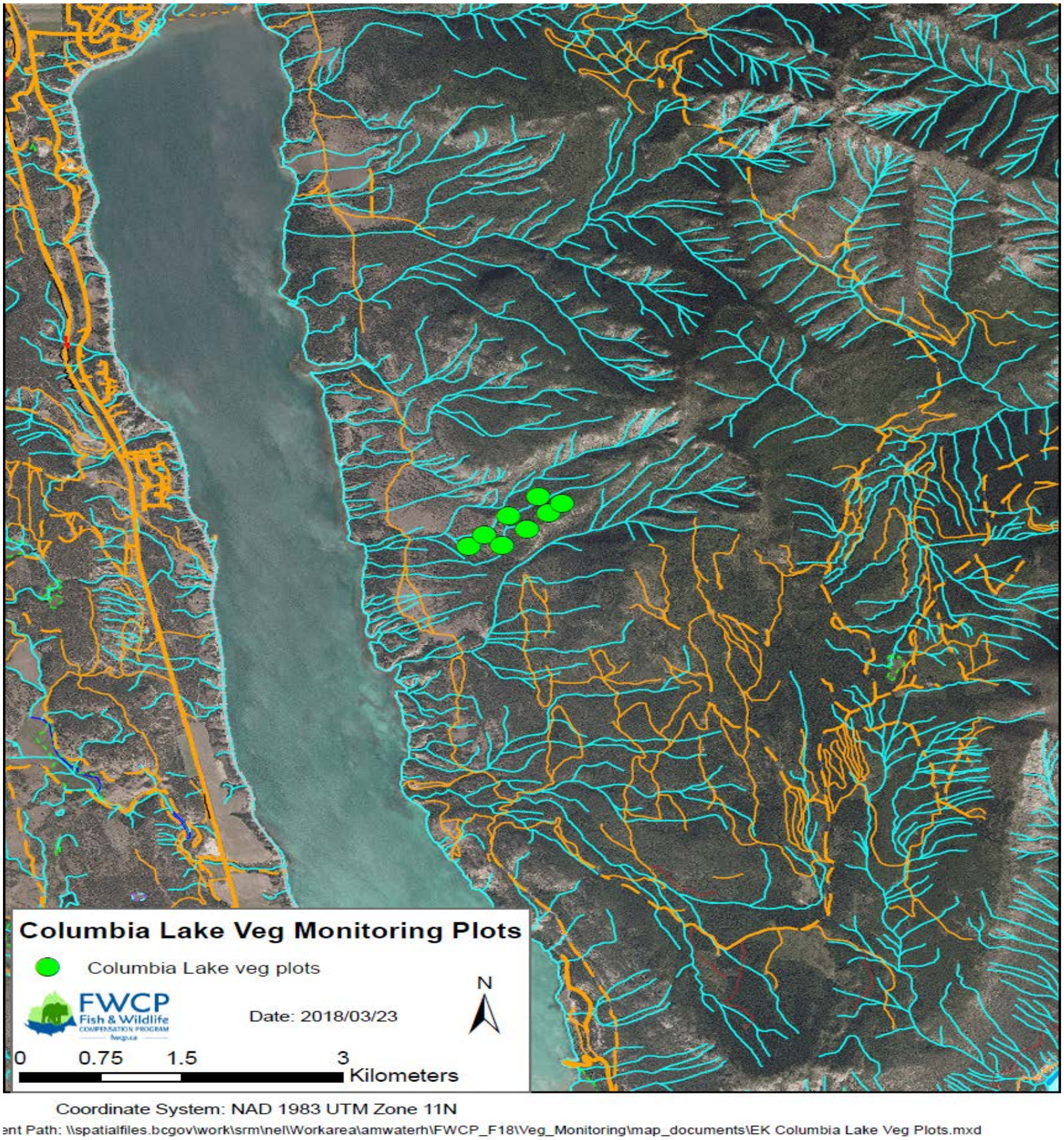

Figure 1: Columbia Lake study area

Methods

Methodology was guided by the East Kootenay Trench Restoration Effectiveness Monitoring Plan (Machmer et al. 2002), for the purpose of ecosystem monitoring at Lizard East, three objectives were outlined:

Restoration Objective 1: To reduce tree density, increase tree size, and achieve a tree species composition that falls within the historical range of variability for treated areas (based on aspect, slope, topography, moisture).

Restoration Objective 2: To maintain or increase fire-adapted native understory vegetation in treated areas.

Restoration Objective 3: To minimize the establishment and spread of non-native plant species, particularly noxious species, in treated areas.

Plot Establishment

Eight plots were established throughout the treatment area using a Garmin 62S GPS; plots were chosen as representative sites and to avoid roads, cliffs and other local topographic anomalies. Plots centres were marked with flagging tape and a 8" steel spike. UTM's of plot centres were recorded. Each plot consisted of four, 25 metre-long transects originating at plot centre; the first transect was assigned a random bearing and the subsequent transects determined by adding 90 degrees and rotating in a clockwise direction. The locations of the Daubenmire frames were also marked using 8" spike and flagging tape on each transect

Understory monitoring

Understory plot layouts were confirmed to methods in Machmer et al. (2002), however; modifications to the plot layout were made to increase the intensity of the data collection per plot. These modifications included: increasing the number of spokes radiating from plot centre from three to four and increasing the length of each spoke to from 11.64 to 25 meters as according to Harris (2014). Five Daubenmire frame locations were permanently marked on each transect (5 frames per transect = 20 total per plot) with a 8" steel spike. The five frames were located at the 5m, 10m, 15m, 20m and 25m intervals along each transect. In addition, duff depths (cm) were taken at 5.3m, 10.3m, 15.3m, 20.3m and 25.3m intervals. At each Daubenmire location, the frame was placed on the right side of transect and the percent cover for all shrubs, grasses, bunchgrasses, forbs and weeds present are documented. In addition to vegetation cover, the percent cover of rock, bare soil, bryophytes, dead and live wood, litter, cryptogrammic crust and scat was recorded as well. Species and ground cover with less than 1%

cover was recorded as 1%. When bunchgrasses or weedy species were observed with a percent cover of five percent or lower the number of culms was individually counted and recorded.

To estimate the shrub cover, the line-intercept method was conducted along each of transect to the full 25 meter length (Figure 2). All shrub species with intercepting cover were recorded to the nearest centimetre. A percent cover was determined per species by calculating the total length of interception along the transect and then dividing by the total length of the transect (25m) to determine a mean cover per species.

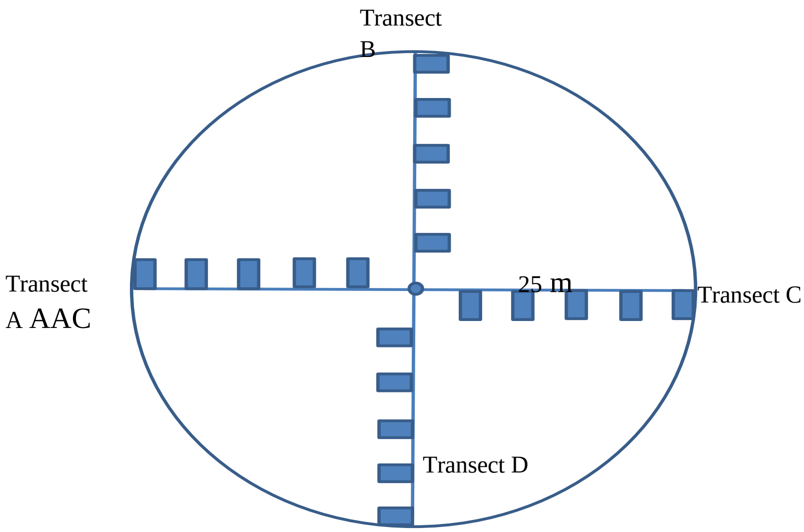

Figure 2: Schematic for understory Daubenmire plot layout

Four photos were taken at four separate representative plots; one photo per cardinal direction taken from plot centre was focused on a one metre tall photo stake positioned approximately five metres from plot centre.

Coarse Woody Debris

Coarse wood debris (CWD) was conducted along transect transects B and D according to BC Ministry of Environment Field Manual for Describing Terrestrial Ecosystems (BCMOF 2010). Any woody debris intercepting the 25 m transects (with a diameter greater than 7.5 cm) was classified as CWD and recorded. For every individual piece the tree species, diameter (cm), length (m), and decay class were recorded. Volume per plot (m^3/ha) was calculated and a mean volume (m^3/ha) calculated. Volume per plot was calculated using the following formula adapted from Van Wagner (1982):

$$V = \sum d^2 \left|\frac{(\pi^2)}{(8*l)}\right|$$

Where:

V=Volume per unit area

d= piece diameter (cm) at intersection

l= length of transect (m)

Overstory monitoring

Overstory plot layout conformed to the BC Ministry of Forests and Range and the BC Ministry of Environment Field Manual for Describing Terrestrial Ecosystems (BCMOF 2010; and Machamer et. al. 2002). Nested fixed radius plots (Figure 3) were established at the plot centres to sample each layer. Species, diameter (at breast height (dbh)), decay class, crown condition, evidence of pathogens and insects and wildlife use was recorded for each tree in the dominant, mature, pole and sapling layers. A tally was taken by species of live and dead regeneration trees between 10 cm and 1.3 metres in height. Due to the high number of germinant trees present (<10cm in height) a tally was taken within 1.78 metre radius plot to determine germinant density. Stand density (stems per hectare (stems/ha)) was calculated using the conversion factor for each layer and is outlined in Table 1. Tree heights and increment bores were randomly taken on two trees per plot in order to determine co-dominant stand height and approximate age of stand. In order to estimate canopy cover, a spherical densitometer was used for each of the cardinal directions at plot centre.

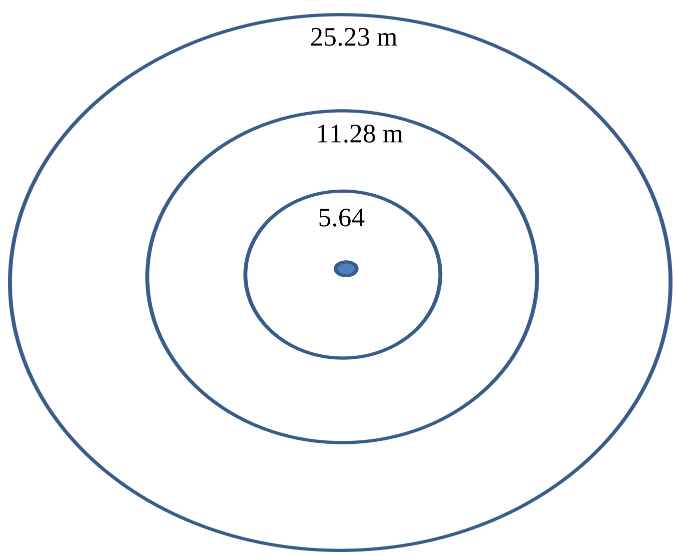

Figure 3: Schematic overstory nested fixed radius plots.

Table 1: Summary of overstory measurements and descriptions for nested fixed radius plots and size/age classes

Radius	Area (m2)	Conversion factor to ha	Size/age class	Height and/or dbh range
1.78	10	10 000	Germinant	<10 cm height
5.64	100	1000	Regeneration	10 cm -130 cm height
5.64	100	1000	Sapling	>1.3 m height, <7.5 cm dbh
5.64	100	1000	Pole	7.5 - 12.49 cm dbh
11.28	400	25	Mature	>12.5 - 30 cm dbh
25.23	1999	5	Dominant	>30 cm dbh

Data Storage

All raw data collected was entered into an excel spreadsheet. This data, as well as the photos taken in the field is stored at: N:\ES\FWCP\EKE Data 2015-2016\2017\Columbia Lake

Results and Discussion

Ecological Site Description

Columbia Lake unit is situated in the IDFdm2 biogeoclimatic zone (Kootenay, dry mild interior Douglas fir variant). Zonal IDFdm2 sites have climates with hot, very dry summers and cool winters with very light snowfall, allowing for soil to dry out during the late summer and to freeze to shallow depths in the winter. The climax stands include Interior Douglas fir *(Pseudotsuga menziesii)* or mixed seral stands of Douglas fir, western larch *(Larix occidentalis)* and lodgepole pine *(Pinus contorta)*. Understory is dominated by pinegrass *(Calamagrostis rubescens)* and shrub species such as birch-leaved spirea *(Spiraea betulifolia),* common juniper, soopilallie *(Shepherdia Canadensis),* Saskatoon *(Amelanchier alnifolia),* and common snowberry *(Symphoricarpos albus)* (Braunmandl 1992).

Rocky Mountain bighorn sheep *(Ovis canadensis)* is a blue listed species provincially and is known to inhabit the area around Columbia Lake as well as the red-listed American badger *(Taxidea taxus)*. Sign of elk, deer and bear was observed on site during plot establishment in June 2017.

Understory

The species richness per plot ranged from 4 (plot 8) to 20 species (plot 5) with an average of 13.75 species per plot (St Dev=5.8) (Figure 3). The number of species across all plots totaled 43 different species.

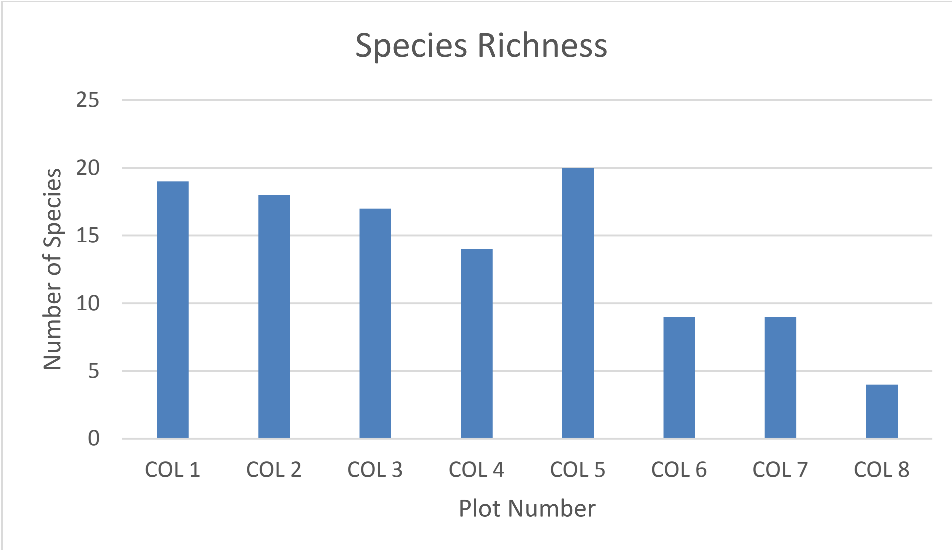

Figure 3: Columbia Lake species richness (does not include tree species)

Daubenmire frames were used at 20 locations within each plot; within the frames the abiotic ground cover was composed predominately of litter (66.5%, St Dev=30.4), followed by soil (25%, St Dev=19.0) and bryophytes (21.9%, St Dev=22.0) (Table 2). The Cryptogrammic crust layer plays a smaller role (10.2%, St Dev=11.9) in the abiotic ground cover than the other components; this is due to the abundance of loose rock and steep slopes throughout the site. Cryptogrammic crust is a thin layer of crusts, composed of mosses, lichens, algae, and bacteria; these crusts form an important function in soil erosion protection as well as moisture absorption and providing nitrogen and other nutrients for plant growth (Ponzetti and McCune 2001). Soils are particularly susceptible to disturbance when the crust is prominent in the ground cover.

Table 2: Mean percent cover of abiotic ground cover

	2017	
	Mean	St Dev
Litter	66.5	30.4
Soil	25.0	19.0
Bryophytes	21.9	22.0
Dead Wood	15.2	20.6
Rock	14.5	18.0
Cryptogrammic Crust	10.2	11.9
Scat	4.2	5.0
Live Wood	0.0	0.0

Throughout the eight plots at Columbia Lake the species with the highest percent cover in the Daubenmire frames were all shrub species: Rocky Mountain juniper (38.1%, StDev=18.5), common juniper (31.7%, StDev=27.5), rabbitbrush (17.5%, StDev=15) and kinnikinnick *(Arctostaphylos uva-ursi) (*17.4%, StDev=7.8).

The species with the highest percent cover in the forb functional group included leafy aster (16%, St Dev=11.4), yellow penstemon (13.3%, StDev=5.7), field pussytoes (11.6%, StDev=7.6) and spikelike goldenrod (9.2%, StDev=5.0).

The bunchgrass group was largely formed of needle-and-thread grass *(Stipa comata)* (16%, St Dev=11.2) and bluebunch wheatgrass *(Pseudoroegneria spicata)* (6.4%, St Dev=4.6) with minor occurrences of junegrass *(Koeleria macrantha)* (7.8%, St Dev=4.4) and Fescue sp *(Festuca sp.)* (4.8%, StDev=4.1). Also common throughout the site was pinegrass (*Calamagrosti rubescens)* (16.2%, St Dev=20.6), a sod forming grass species; and cheatgrass *(Brome tectorum)* (15%, St Dev=7.1), a weedy, introduced grass species.

Table 3: Mean percent cover of understory functional groups

	2017	
	Mean	St Dev
Shrub	19.2	13.5
Grass	15.6	0.8
Bunchgrass	9.0	6.1
Forb	6.2	3.5
Weed	3.8	1.4
Sedge	0.0	0.0

The average percent cover of all present shrub species in the 100 metre (four 25 metre transects) line intercept was 5.4% (St Dev=0.6) (Table 4). The species within the shrub layer with the highest percent was Rocky Mountain juniper (2.0%, St Dev=1.7), kinnikinnick (1.2%, StDev=0.9) and common juniper (1.1%, StDev=0.9) Other shrub species present but with a lesser percent cover were common rabbitbrush, birch-leaved spirea and baldhip rose. All shrub cover was less than two metres in height.

Table 4: Mean percent cover of shrub species in 5.64 m radius plot

	Mean	St Dev
Rocky Mountain juniper *(Juniperus scopulorum)*	2.0	1.7
Kinnikinnick *(Arctostaphylos uva-ursi)*	1.2	0.9
Common juniper *(Juniperus communis)*	1.1	0.9
Common rabbitbrush *(Chrysothamnus nauseosus)*	0.5	0.4
Birch-leaved spirea *(Spiraea betulifolia)*	0.4	0.2
Baldhip rose *(Rosa gymnocarpa)*	0.2	0.0

Coarse woody debris with a diameter of 7.5cm or greater was found at one of the eight plots (COL 7) at Columbia Lake. Three separate CWD intercepted transects B and D with the volume of 66.4 m^3, 92.56 m^3 and 359.75 m^3 for a total of 518.71 m^3/ha in plot 7 and 0 in the other seven plots.

Overstory

The overstory of Columbia Lake treatment unit is characterized entirely by Douglas fir *(Pseudotsuga menziesii)* no other tree species were located within the 25 metre radius plots. The mean percent crown closure was 9.7% (St Dev=7.1). The trees ranged in height from 12.2 metres to 21.6 meters, averaging 15.6 metres (St Dev=2.8). The average age for the stand was 50.4 years (St Dev=14.6). The stem diameter distribution indicates the majority of trees within the plots are classified as either dominant (52%) or mature (36%) with minor instances of pole (1%), sapling (11%) and regen (1%).

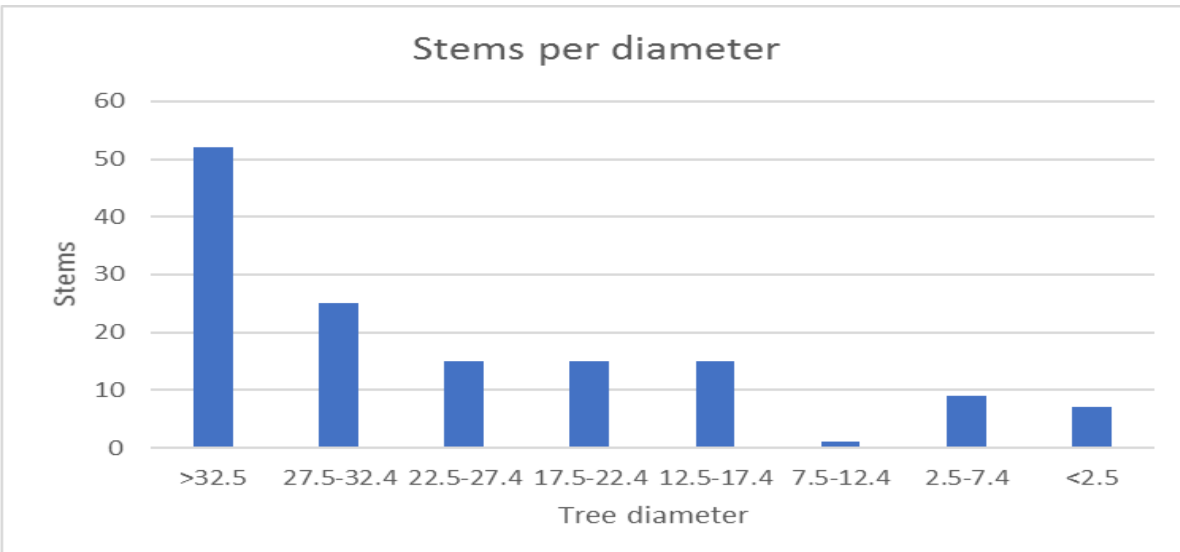

Figure 4: Stem diameter distribution (does not includes regeneration layer)

The germinant layer (<10 cm in height) was counted as individual trees in a 1.78 metre diameter plot (10 square meters) instead of a 5.64 metre diameter plot as the number of trees per plot was extremely high. These trees are unlikely to survive the hot summer months but were tallied nonetheless. Plots ranged from 6 trees to 312 trees per 1.78 metre plot (mean=110.4 trees, StDev=124.6). The high number of germinants present resulted in an extremely high density for the layer that was not taken into consideration when determining the stem density for the treatment unit.

After the germinant density, the sapling layer had the highest density of stems per hectare with an average of 2,000 stems per hectare (stems/ha) followed by the regen, mature, pole and dominant layers (Table 6.).

Table 6: Stems per hectare by tree species and layer

		2017		
Layer	Species	Count	Mean Stems/ha	St Dev
Dominant	Fd	72	45.0	28.5
Mature	Fd	50	156.3	104.2
Pole	Fd	1	125.0	0.0
Sapling	Fd	16	2,000.0	5,715.5
Regen	Fd	2	250.0	516.4
Germinant	Fd	994	1,240,000.0	1,169,284.7

The entire overstory, excluding the germinant layer, had an average of 2,576 stems/ha (St Dev=2,492.2). The stem densities are presented in Figure 5. These numbers do not fall within the targeted stems per hectare for an open forest system (76-400 stems/ha) set out by Machmer (2002).

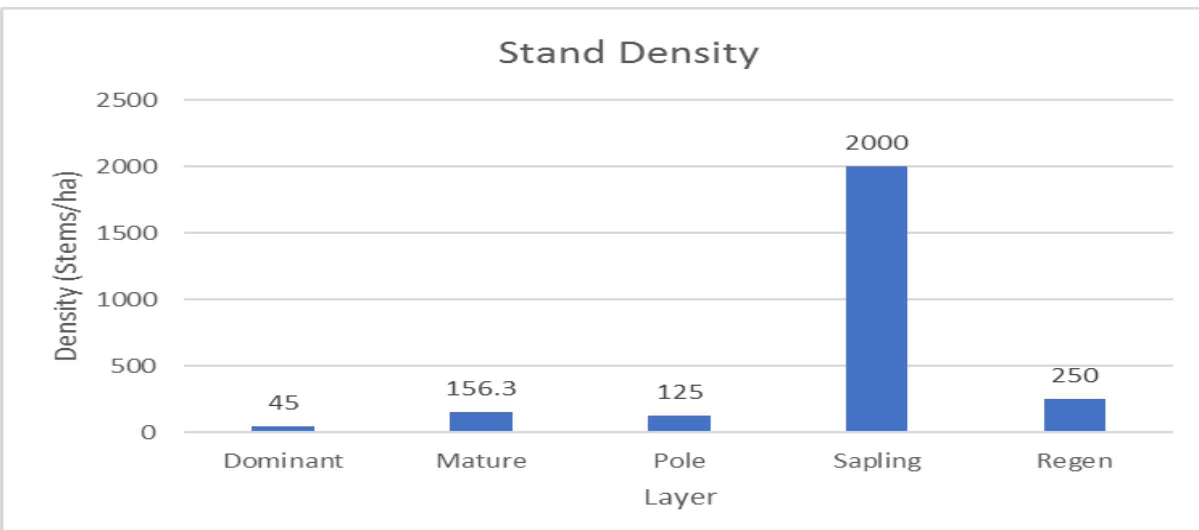

Figure 5: Stems per hectare by layer

Recommendations

Currently, the stand density within the vegetation monitoring plots at Columbia Lake is higher than the targeted density for open forest ecosystems. These calculations do not take into consideration the areas of dense Douglas fir germinant ingrowth; however, it is extremely unlikely that these germinants will live to maturity. Rejuvenating these areas to a density of an open forest system would increase the value of the site as an ungulate winter range.

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