Huckleberry Monitoring in the Gifford Pinchot National Forest

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Introduction

This report outlines our findings for huckleberry surveys conducted in the summers of 2017 and 2018 in the Gifford Pinchot National Forest. The objectives of this project are to: (1) survey units within the Pole Patch and Sawtooth huckleberry restoration treatment areas in order to evaluate the effectiveness of different silvicultural treatments in enhancing production and growth of big huckleberry (*Vaccinium membranaceum*) and (2) engage community members, stakeholders, and volunteers in monitoring activities. Our goal is to aid ecologically similar areas throughout the Pacific Northwest in being able to adopt effective and data-supported huckleberry restoration strategies. The overarching monitoring question we aim to answer is: To what extent did vegetation management impact huckleberry cover, fruit production, plant height, and ecosystem characteristics within the plot and unit?

This work has been carried out in partnership with Pinchot Partners under grants from the Weyerhaeuser Family Foundation and the Rural Advisory Council (RCA). Jeff Gerwing (Portland State University), Jessica Hudec (U.S. Forest Service), and other staff members of the Gifford Pinchot National Forest assisted us in planning and refining this work. Volunteer citizen scientists have been instrumental in helping us collect data in the field, with community members offering over 611 volunteer hours in service of the project. This report is a preliminary report for the project – a final report will be completed at the conclusion of year two (December 2018).

Survey areas

Figure 1 shows the area of study. We focused on two main project areas, Pole Patch and Sawtooth, both located in the Gifford Pinchot National Forest. Although the ecological conditions in these two areas are slightly different and huckleberry growth responses can be expected to vary in ways that are unrelated to treatment type, these areas do share many ecological characteristics and are in close enough proximity to allow us to combine their data for some purposes. We explore the results both separately and together.

Five units within Pole Patch (Pinto 6, 7, 8, 9, and 11) and six units within Sawtooth (Sawtooth 3, 8, 9, 10A, 11A, and 12) had undergone treatment to promote the growth of huckleberries. These units were all surveyed in 2017, with the exception of Pinto 6, Pinto 11, and Sawtooth 12. In 2018, we surveyed Pinto 6, Pinto 11, and Sawtooth 12 and revisited all of the units surveyed in 2017 to increase the amount of plots per unit. Most of the units we surveyed were treated (thinned) between 2010 and 2017. In addition to surveying plots in these project areas, we also monitored management units treated under a non-commercial thinning prescription (referred to as NCT) that was intended to promote huckleberry growth (with spacing between 16 x 16 and 18 x 18). We also surveyed control plots, which were located in comparable forest areas next to huckleberry treatment areas. In total, we visited 309 survey plots in 2017 and 2018 combined.

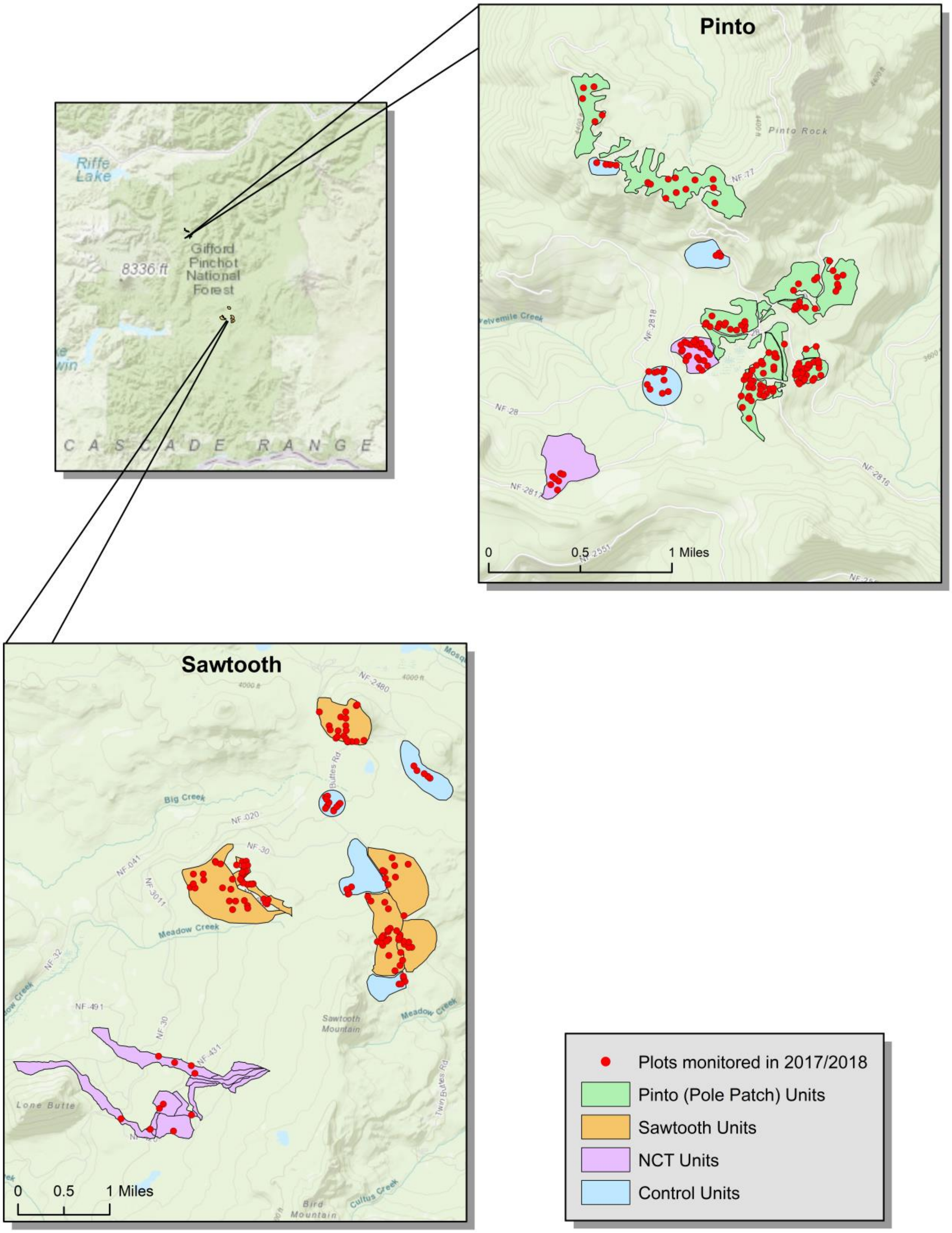

Figure 1: Map of the two survey areas, Pinto (Pole Patch) and Sawtooth. The red dots are the plots that were monitored in 2017 and 2018. The two years were combined for the analysis.

Survey protocol

Our survey protocol is outlined in Appendix A. In short, we aimed to investigate how the abundance of huckleberry plants, fruit production, and plant height were related to treatment variables such as treatment method and canopy cover. At all survey sites, we monitored huckleberry and ecological characteristics in 100m^2 plots and captured fine-scale observations of huckleberry growth in 2m^2 subplots.

Analysis and Results

Data collected

We collected data at 309 plots in fourteen treatment units and eight control units in surrounding areas that had not been recently thinned for huckleberry restoration. Table 1 shows the variables that are summarized and analyzed in this report.

Table 1: Variables collected at each plot, variable notation used in the text, and the range of values for that variable documented during the study.

Continuous variables	**Notation**	**Values observed**
Huckleberry percent cover	HC	0-90
Huckleberry: log(HC+1)[a]	logHC	0-1.95
Canopy percent cover	CanCov	0-100
Canopy percent cover squared [b]	CanCov^2	0-10000
Categorical Variables	**Notation**	**Values observed**
Fruit Production	Prod	No fruit, low fruit, medium, medium-high[c]
Plant Height	Height	< 0.1 m, 0.1 – 0.5 m, 0.5 – 1 m, > 1m
Method of harvest	Method	Ground based machinery, hand tools, none

[a] HC data was transformed to meet the assumption of independently distributed residuals in linear models.

[b] CanCov was squared to allow for modeling a curvilinear relationship using a linear model.

[c] Explanation of fruit production categories can be found in Table 3.

Canopy Cover

For each unit, we calculated mean percent canopy cover across all plots to estimate overall canopy cover for that unit. Previous research has found an average of 30% canopy cover to be most beneficial to huckleberry (Martin 1979). Reducing the overstory canopy can increase available sunlight and may promote fruit production. However, a canopy that is too open may not provide protection from heat stress and overexposure. Forest managers prescribed a canopy cover for each unit, and timber harvest contractors thinned the units - using various means - to match the target prescription. To better understand this relationship, we compared mean canopy cover to the prescribed canopy cover for each unit (Figure 2). The measured canopy cover in the treatment units ranged from 20% to 40%.

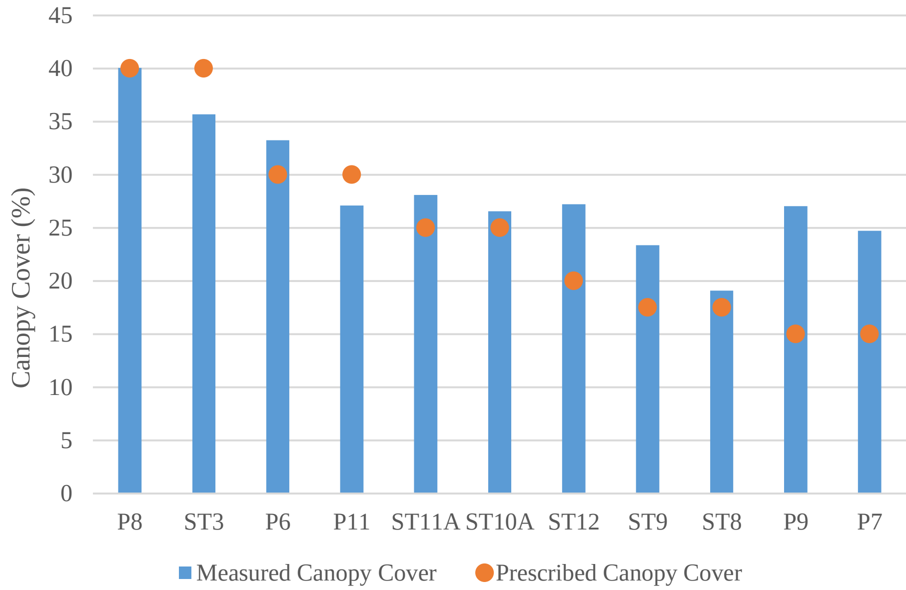

Figure 2: Mean percent canopy cover measured in 2017 and 2018 for each surveyed unit as compared to the prescribed canopy cover (P: Pinto; ST: Sawtooth). NCT and Control units not included.

Huckleberry Cover

At the unit level, mean huckleberry cover ranged from 8% to 56% (Table 2). Ten of the sixteen units surveys had at least one plot with no huckleberry. The highest huckleberry cover measured at the plot level was 90%.

Table 2: Number of plots surveyed, mean huckleberry cover, and range of huckleberry cover for each unit surveyed in 2017 and 2018.

Unit	n	Zone	Harvest Method	Mean HC	Range
PCtrl	17	Pinto	NONE	7.47	0-35
P9	28	Pinto	GBM	7.57	0-40
ST11A	20	Sawtooth	GBM	12.8	0-85
P8	16	Pinto	GBM	13.69	0-60
P7	35	Pinto	GBM	17.26	0-80
PNCT556	24	Pinto	HT	17.29	0-75
P6	16	Pinto	GBM	18.5	1-87
P11	21	Pinto	GBM	21.38	0-75
ST3	20	Sawtooth	GBM	22.5	0-60
STNCT	10	Sawtooth	HT	22.6	3-60
ST8	12	Sawtooth	HT	22.83	2-60
STCtrl	32	Sawtooth	NONE	25.16	1-90
ST12	18	Sawtooth	HT	26.78	1-85
ST10A	14	Sawtooth	GBM	27.5	0-60
PNCT543	7	Pinto	HT	34.14	0-60
ST9	19	Sawtooth	HT	56.42	7-85

We were interested in whether the percentage of huckleberry cover within plots was influenced by either canopy cover and/or the method (or lack) of timber harvest. To test the relationship between canopy cover and huckleberry cover and allow for a curvilinear relationship, we used a linear model with logHC as the dependent variable and both CanCov and $CanCov^2$ as independent variables.

$$logHC = \beta_0 + \beta_1 * CanCov + \beta_2 * CanCov^2 + \varepsilon$$

In this model, $CanCov^2$ ($t=-2.367$, $df=306$, $p=0.018$) was found to be significant, but CanCov ($t=1.506$, $df=306$, $p=0.133$) was not. Figure 3 provides visual support for a curvilinear relationship and indicates that canopy cover values between 21% and 40% supported the highest percentage of huckleberry cover.

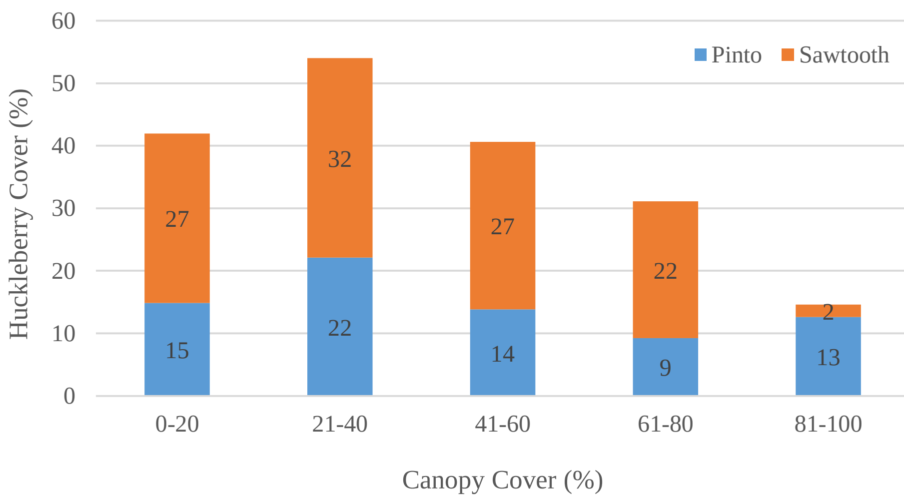

Figure 3: Mean huckleberry cover of plots within Pinto and Sawtooth as related to mean percent canopy cover.

To test whether huckleberry cover varied among areas with different treatment methods (ground-based machinery, hand tools, and no treatment) while controlling for differences in canopy cover, we used a multifactor linear model that included both canopy cover variables (CanCov and $CanCov^2$) as well as Method as an additional factor variable.

$$logHC = \beta_0 + \beta_1 * CanCov + \beta_2 * CanCov^2 + \beta_3 * Method + \varepsilon$$

When controlling for differences in canopy cover, we found that treatment method had a significant relationship with huckleberry cover. Specifically, we found that the use of hand tools had a positive relationship with huckleberry cover compared to the use of ground-based machinery ($t=4.983$, $df=304$, $p<0.001$). Further, when controlling for harvest method, the apparent relationship between canopy cover and huckleberry cover was strengthened and both CanCov ($t=2.020$, $df=304$, $p=0.044$) and $CanCov^2$ ($t=-2.913$, $df=-2.913$, $p=0.003$) were found to be significant in this model. Figure 4 illustrates that while plots treated with hand tools had similar canopy cover to those treated with ground-based machinery, huckleberry cover was higher at the hand tool sites.

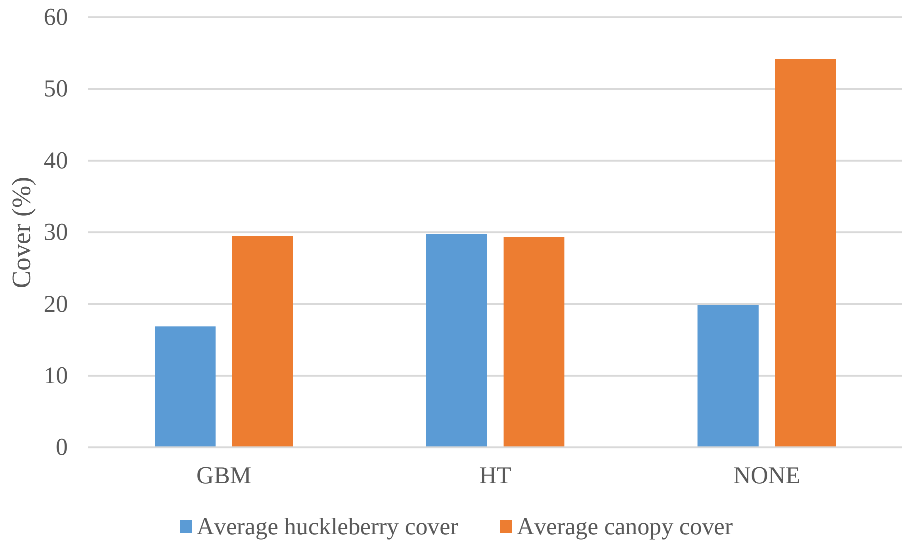

Figure 4: Mean huckleberry cover and canopy cover of plots within the different treatment methods. GBM: ground-based machinery, HT: hand tools, and NONE: no treatment.

Fruit Production

Fruit production data were collected at three subplots within each plot. Of the 618 subplots that contained huckleberry, 208 produced fruit (0.34). We were interested in whether huckleberry plants within areas with different types of treatment methods produced fruit in different proportions. Separated by treatment method, the proportions are as follows: ground-based machinery (GBM): 0.25, hand tools (HT): 0.42, and no treatment (NONE): 0.44.

We conducted a chi-squared analysis which indicated that, overall, these proportions were significantly different than expected by chance (χ^2=20.4, df =2, p<0.001). A post-hoc test showed significant differences between GBM and HT (χ^2=14.5, df=1, p<0.001) and GBM and NONE (χ^2=11.5, df = 1, p<0.001). Fruiting proportions were similar between HT and NONE.

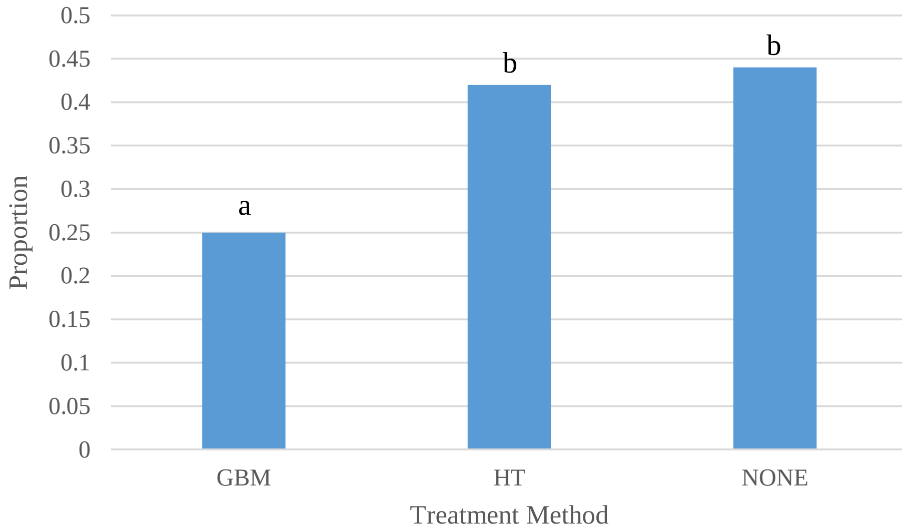

Figure 5: Proportions of subplots in each treatment method that contained huckleberry plants that were producing fruit. Letters above bar indicate the significant difference between methods. Those with the same letters, have no significant difference and those with different letters have a significant difference.

Of the 208 subplots that produced fruit, 189 (0.90) produced at levels classified as low production (class 2 in Table 3). Only 21 subplots supported plants that produced fruit at medium or medium-high levels (classes 3 and 4). For analysis we combined classes 3 and 4 (there was only 1 subplot in the medium-high category), hereafter referred to as medium production.

Fruit Production Class	Class Definition
0	No huckleberry plants in plot
1	Huckleberry plants in plot, no fruit
2	Low (<5 fruits on all stems)
3	Medium (<5 fruits on most stems, 5-10 fruits on others)
4	Medium-high (<10 fruits most stems, 10-15 fruits on others)
5	High (< 15 fruits most stems, 15-20 fruits on others)
6	Extra-high (>20 fruits on most stems)

Table 3: Definitions of fruit production categories modified from Anzinger 2002.

The proportions of subplots that produced low fruit in each treatment type are as follows: GBM - 0.96, HT - 0.88, NONE - 0.81. We conducted a chi-squared analysis which indicated that the proportion of plants that produced the most fruit was found in areas of no treatment, followed by hand tools, with ground-based machinery have the lowest proportion (Figure 6).

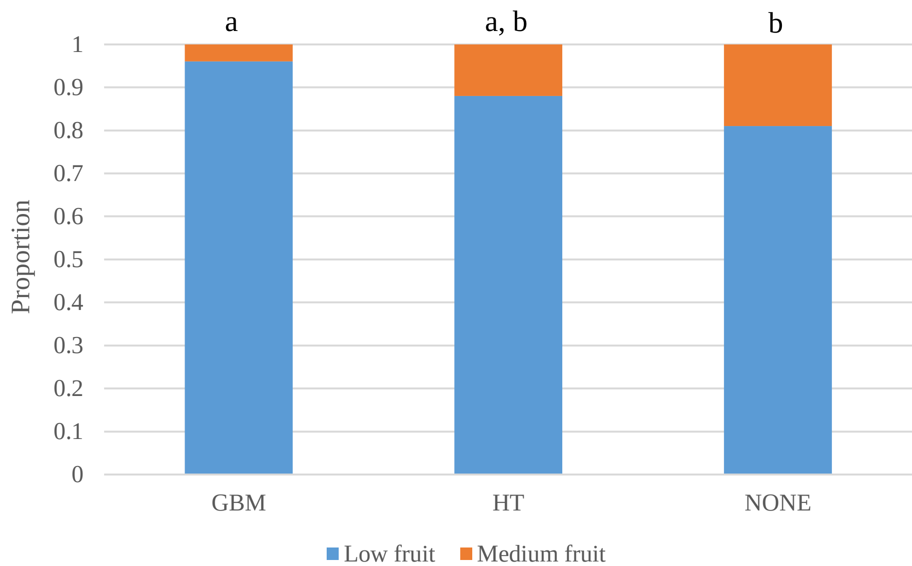

Figure 6: Fruiting levels for each treatment method (only considering subplots that had fruit). Letters above bar indicate the significant difference between methods. Those with the same letters, have no significant difference and those with different letters have a significant difference.

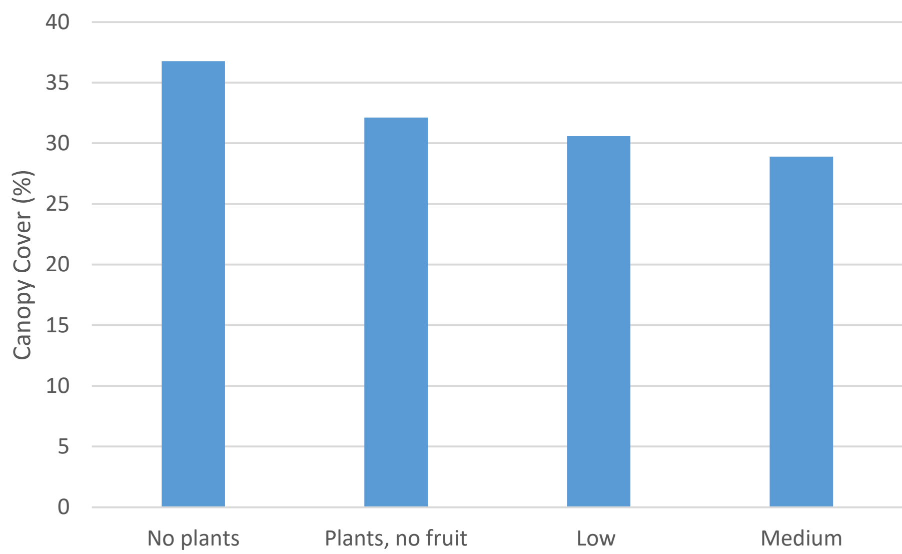

Figure 7: Mean canopy cover at subplots with different plant and fruit production values.

Discussion

Huckleberry cover

At the plot level, we identified a significant curvilinear relationship between huckleberry cover and canopy cover when treatment method was accounted for in the model. The highest percentage of huckleberry cover was found at 21-40% canopy cover. This result parallels other studies that have shown an increase in huckleberry abundance up to 30% canopy cover and then a decrease in huckleberry abundance as canopy cover increases (Douglas 1970, Minore 1972, Lotan et al. 1981).

Further, the treatment method of hand tools showed a positive influence on huckleberry cover, compared to ground-based machinery. While overall mean canopy cover was similar at the plots treated with ground-based machinery and hand tools, huckleberry cover was significantly higher in units treated with hand tools. The extraction of overstory trees with hand tools limits the amount of damage to huckleberry shrubs and prevents ground disturbance, which could ultimately affect the process of vegetative reproduction. Some ground disturbance is beneficial as it can stimulate shoot development, but too much ground disturbance or compaction can be detrimental to their shallow rhizomes (Minore 1979, Strik et al. 1993, Barney 2005, 2008). It is possible that disturbance caused by the ground-based machinery could have had an effect on the vegetative growth of huckleberry plants resulting in lower levels of huckleberry cover throughout those plots.

Fruit Production

The majority of subplots with huckleberry plants did not produce fruit. However, subplots in hand tool and no treatment units produced fruit in higher proportions than in units treated with ground-based machinery. Similar to the potential damage to the rhizomes (affecting huckleberry percent cover) by ground-based machinery, the stems and foliage of the plant could be in jeopardy when machinery is used. Our findings support previous studies that have documented an increase in fruit production when the treatment methods used for overstory removal produced minimal damage to huckleberry plants in the understory (Minore 1984, Kerns 2004).

While other studies (Martin 1979, Minore 1984) have documented inverse relationships between canopy cover and fruit production, our analysis did not identify this result. We believe this relationship could become stronger when controlled by additional variables.

Next steps

Findings presented in this report offer additional support to previous research on huckleberry growth and fruit production. Specifically, both canopy cover and harvest method have an impact on this species and should be considered when designing huckleberry management plans.

However, a great deal of the variability in our response variables was not explained by these two predictors. This is likely due in part to the substantial variability in other environmental characteristics both between and among units. Moving forward, we intend to develop, test, and compare a diverse set of competing models to build a more complete understanding of the factors that contribute to this species' successful establishment and fruit production. Models will include elevation, slope, solar radiation, presence of potential competitors, and timing since management. We also plan to test whether the same factors were important in both years of the study and across both the Sawtooth and Pole Patch.

Appendix A.

Survey protocol

Plot Establishment (see Figure 1 in report)

We established plot locations using the random point generator in ArcGIS. We designated 30 randomly selected points at each unit to use for survey. Our goal is to survey at least 10 plots within each treatment unit (or control area). We designated extra plots because some plots will not be reachable, others may encompass areas that are not suitable for survey (such as roads or camping areas), and there are time constraints that will limit the number of plots accessed.

Plots and Subplots

At each survey plot, a $100m^2$ plot will be established using the randomly generated point as the center of the plot. Three $2m^2$ square subplots will be established within the larger plot for finer scale observations of huckleberry phenology, with one at the center of the $100m^2$ plot, one 1.4m north from the edge of the center plot, and one 1.4m south from the other edge of the center subplot (see Figure 1 below).

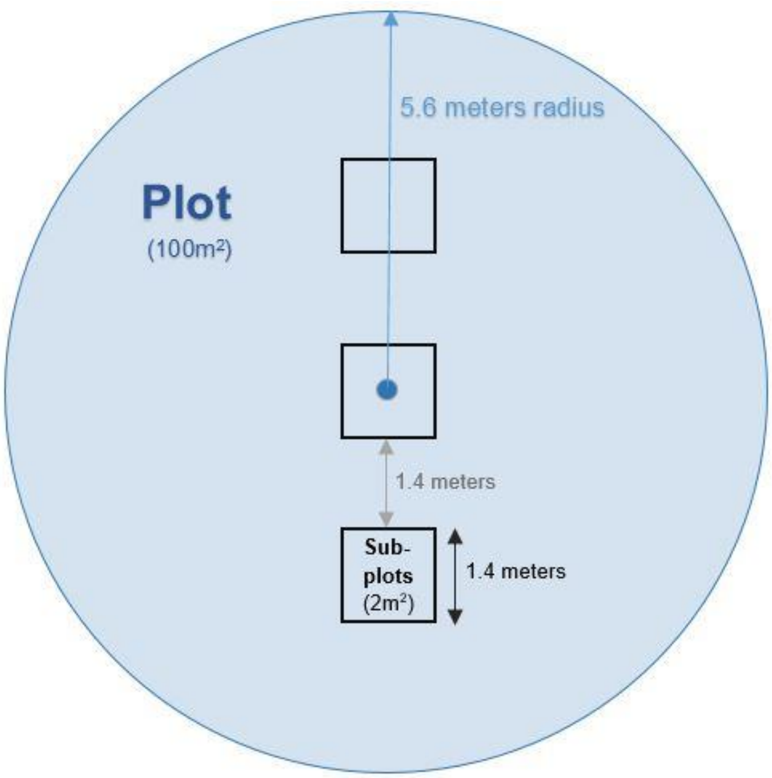

Figure 1. Survey plot and subplots.

Photopoints

One photopoint will be taken at a subset of the plots within each unit. Each photo will be taken from the center point and facing north. In 2018, we will be following up on previously established photopoints in the Pole Patch project area set by the Forest Service.

Data Collection – Plot Level

The following observations and measurements will be recorded at each 100m^2 plot:

- **Extrapolation of treatment**
  - Type of treatment/year treated, none, unsure, burned or unburned
- **Aspect**
  - N, NE, E, SE, S, SW, W, NW, flat
- **Approximate percent cover of huckleberry**
- **Spatial distribution of huckleberry**

  1 – Located mainly along forest edges
  2 – Scattered or clumped distribution
  3 – Fully distributed throughout the plot

- **Presence and percent distribution of other Vaccinium species**
- **Presence of invasives**
  - Y/N, make note if prominent species is known
- **Approximate percent cover of beargrass**
- **Soil disturbance**

  None – No observed soil disturbance
  Low – Topsoil is compacted but not churned
  Moderate – Topsoil is moderately churned or compacted
  Severe – Topsoil is severely churned or compacted
- **Biodiversity** of surrounding vegetation (general and quick observation, approximate classes)

  Class 1: 0–3 different understory shrubs/grass
  Class 2: 3–5 different understory shrubs/grasses
  Class 3: >5 understory shrubs/grasses

- **Percent canopy cover** (average of five readings: facing north for each reading, collect one at the plot center and one in each cardinal direction at the plot edge).
- **Stem density of trees / stems in the plot** (delineate live or dead)

Data Collection – Subplot Level

The following observations and measurements will be recorded at each 2m^2 plot (see tables 1, 2, and 3):

1. **Status of huckleberry production**
2. **Ripening status**
3. **Average plant height**

Sampling would ideally occur during the beginning and middle of huckleberry ripening (before humans and other animals have removed the berries). We will note if areas have been harvested by humans or other animals. Huckleberry fruit production and phenology will be assessed using 2m^2 subplots. Fruit production and phenology will be recorded using the classifications from the tables below. The classification is used for both ripe and green fruit, but an additional classification system will be used to identify most fruit within the plot as green, ripe, or fallen/taken. Plant height will be estimated as an average for the unit.

Table 1. Categories for assessing huckleberry fruit production (Anzinger 2002).

Fruit Production Class	**Class Description (ripe or green)**
0	No huckleberry plants in plot
1	Huckleberry plants in plot, no fruit
2	Low (< 5 fruits/stem on all stems in plot.)
3	Medium (<5 fruits/stem on most stems in plot, between 5-10 fruits on others.)
4	Medium-high (< 10 fruits on most stems in plot, between 10-15 fruits on others.)
5	High (< 15 fruits on most stems in plot, between 15-20 fruits on others.)
6	Extra high (>20 fruits on most stems in plot.)

Table 2. Categories for assessing ripeness of fruit

Fruit Ripeness Class	**Class Description**
0	No ripe fruit
1	Up to half of the fruit is ripe
2	Most or all the fruit is ripe
3	Up to half the fruit fallen/taken
4	More than half the fruit fallen/taken

Table 3. Categories for assessing average heights of all huckleberry plants within a single plot

Height	Class Description
X-Small	Average height less than 0.1 m (4 in.)
Small	Between 0.1 m and 0.5 m (4 in. – 1.6 ft.)
Medium	Between 0.5 m and 1 m (1.6 – 3.2 ft.)
Large	Greater than 1 m (3.2 ft.)