Optimization of diversity-functioning relationships in stratified Conifer-broadleaf forest mixtures, and the effects of Spruce Weevil Damage

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Abstract

Sitka Spruce once was the timber of choice for the thriving timber Companies (Fig. 2), providing jobs and habitat for food sources, to local communities because of it's many uses. It grows naturally around the Pacific Northwest area. Due to the destruction of Spruce Weevil (Fig.4 and 5) it has been largely phased out of plantations.

Cool temperatures along coast lines is believed to deter this pest (3). This research attempts to use a canopy of faster maturing Red alders to lower temperatures among different densities, and ratios of Sitka spruce to Red alders. Exploring these densities and ratios will help to find the best proportion for mixed tree stands that can not only provide habitat (Fig.3), and allow for multiple rotating harvest within one stand, but also to determine the best possible mix so that the Spruce weevil can be deterred. This research will give us information that could allow us to reintroduce this natural species back into the timber stands of the Chehalis River Basin, to better serve its communities.


Figure 1 Black tail deer
Photo: John Mcadams


Figure 2 Sitka Spruce
Photo: The Whitney Co.


Figure 3 baby Robins sleeping
Photo: Colleen Purefoy

Introduction

The Sitka spruce is one of the most popular hardwoods used in the timber industry, and the most profitable globally. Its wood is light, and flexible giving it uses in many industries such as construction, ship building, paper, and musical instruments. Dense Sitka stands can limit the diversity of vegetation, therefore limiting wildlife habitats (Deal), but mixed stands are beneficial by increasing habitats for multiple species like black tail deer, grizzlies, black bear, and many other smaller creatures that can reside below the canopy (Fig. 1,3).

Sitka spruce grow naturally in temperate zone rain forest, which include the coastal areas of the Pacific Northwest, with three other dominant species; Douglas fir, Western Red cedar, and Western hemlock. It grows 70 to 90 meters tall, and 2.5 to 5 meters across, making it the largest species of spruce available and the best for yield; and has been regarded in the Chehalis River Basin as a highly profitable timber harvest since the timber industry began here. Sitka spruce can thrive in poor soil, and previous studies have shown that it also regenerates itself well in the right conditions. The Sitka spruce also has unique ability to take in minerals from the fog, making it an ideal species in plantation stands for harvest (1) around the Chehalis River basin.

Over the last decades Sitka spruce has become unpopular in plantations due partly to slow growth in its early ages, and the top kill created by the Spruce weevil. The Spruce weevil burrows into the main vein, through the terminal bud killing the top. It lays its eggs in this vein, and when temperatures warm they hatch. This burrowing causes the top to split, stopping that year worth of growth for that specimen, greatly reducing the yield of timber, and also effecting the possible mortality of the specimen, in turn effecting habitats of the above-mentioned species, and making it difficult to maintain. a

Cool ocean breezes and fog deter weevil infestations among coastal Sitkas (3). Lowering temperatures in stands of Sitkas needs to be explored to evaluate whether these temperatures are in fact a deterrent to this destructive weevil. Previous studies have shown that Sitka spruce can be grown in stands beneath faster growing beech trees (6). This implies that there is the possibility that lowering temperatures among Sitka stands could reduce infestation, in poly cultured plots. The Red alder is a fast growing, broad leafed species that also grows well in the Pacific northwest and will be tested for these purposes in the research.

The Chehalis river basin is a culturally diverse community that depends on the fruits of the environment for sustainability. The Sitka spruce, grown in polyculture stands, helps maintain stability of habitats for food sources that are staples in the local community diets, through hunting, and fishing.

By learning how to grow disease free, Sitka spruce, in abundance, of poly cultured stands it will also help to sustain timber industries that support the local economies. These intercrops of Sitka spruce and Red alder, offer the potential of surplus timber by harvesting two species on one plot, making a better facilitation of land use that is more cost efficient to maintain. A strong timber industry helps stimulate the standard of living for inhabitants of the Chehalis River Basin through increases in employment opportunities.

Methods

This research was conducted at the Satsop business park outside of Satsop, Washington. This facility contains approximately 2,000 acres owned by the Port of Grays Harbor and managed by Grays Harbor College as their school forest. This research will be ongoing; plots were established in 2012 with 1 x 1 trees (juveniles grown indoors for 1 year, and 1 year of outdoor growth). Plots were established on grids of 25m x 25m, on reasonably flat ground.

Data was collected on each specimen on a yearly basis between July and September. 27 research plots with stands of different ratios of Sitka spruce to Red alder; ranging from only Red Alder, to mixes of both, then to all Sitka spruce to determine the best mixture for optimal growth of both species, and allowing monitoring of the weevil within those ratio stands. Data was not collected for the year of 2016. In 2017 from July to August Data was collected from the 27 plots. Data was collected to determine the diameter and height of planted stand specimens thus far, and observations were made to note forked tops, dead tops, and other visual anomalies.

Using pruners and hand shears, we cut to the trees removing understory of Blackberry, Salmonberry, and various other vegetation (Fig.6,7,8), to locate marked project trees. All trees planted for this project were marked with metal tags, labeling them with plot number, then tree number within the plot, and surrounded by biodegradable baskets. If a tag was missing it was replaced so that it could be located in the future.

Once specimen was located we cleared a five-ft. diameter around tree, and pruned to approximately a 6-ft. height on trees above 12 ft., to allow light for better photosynthesis. If trees were forked then the best viable sprout was kept and the other clipped to ensure upright growth. Removal of competing volunteer trees were also removed to maintain original stand ratios.

Using a D-tape, or Diameter Caliper tool, diameter of tree was measured at 4.5 ft. height of main trunk. Trees under 4.5 feet were measured at base. Height was measured using a 15-ft. telescoping optical measuring rod for trees under 15 ft., and a Relescope for trees above that height. Data and remarks, or anomalies for each tree was noted on appropriate data sheets.


Figure 6 Salmon Berry bushes
Photo: Native Plants PNW


Figure 8 Blackberry bush
Photo Humeseen.com

Discussion

This study is ongoing research, due to the growth rate of trees. All data collected is within the first five years of what is a 25+ project. This data is extremely preliminary, and results are ongoing. For the purpose of this particular research, focus is on the visual remarks noted for each specimen, and how that relates to the different densities and ratio of plots. Densities were established as low (fig.9), med (fig.10), and high (fig.11) plots, being 25m X 25m, with low plots containing 36 trees in a 6 X 6 arrangement, medium plots 64 trees in a 8 X 8 arrangement, and high in a 10 x 10, or 11 X 11 arrangements with totals of 100, or 121. Ratios for each density were arranged from 1:1 – 1:5 (Sitka,SS: Red alder, RA) to maintain uniformity.

In Figure 9 we see that most notable is the death for RA is higher than all other remarks, but that the higher ratio of RA to SS shows reduction in deaths for low density plots. SS deaths are minimal in this scenario, and show no forking. Number of forking among RA remains between 1-5 in each plot, suggesting better photosynthesis for both species in low density planting, which could suggest less pruning maintenance for this density of stand. The only dead tops noted for low density plots are in ratios of 1:0, and 1:1, possibly suggesting higher infestation of weevil within stands of mostly SS.

In Figure 10 RA deaths increase as the number of SS in the ratio increases. There is more forking of the RA in this scenario when the number of RA are increased, suggesting that less RA in the ratio, less maintenance, but higher mortality of RA. The pure SS stands show forking of the SS, along with a few in the 1:1, and 1:3. Dead tops are highest among the 1:1 ratio.

In Figure 11 There is an increase of deaths in the ratios of 1:2, and 1:3 for RA. Forking is greater among ratios with higher number of RA. For the SS, we are seeing definite increases in forking, and dead tops when RA is lowered in the ratios 1:1, and 1:0. Dead SS are showing only in plots of 1:1, and 1:0.

A significant part of the data showed that when forked trees were pruned, the following year the specimen were growing upright and well with only one main vein. This shows that pruning will lower the amount of trees lost to fork top, and increase biomass for revenue.

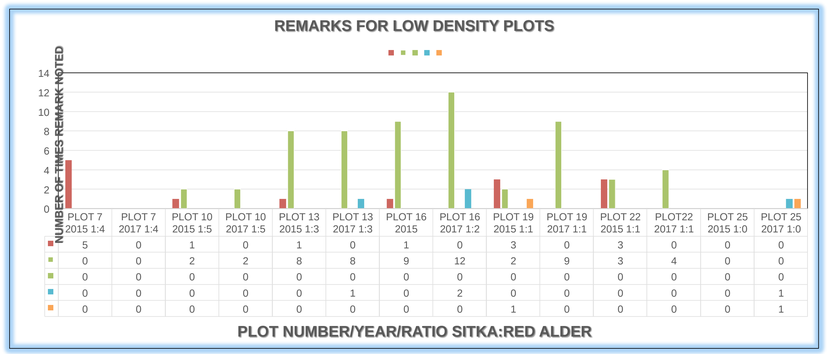
Preliminary data shows that low density plots may be the best scenario for overall mortality of both species; less forking, and dead tops are also noteworthy.
Medium density plots have less dead RA, but a higher forking rate, which could be beneficial to timber harvesters because this would increase biomass, with some early maintenance to stands.

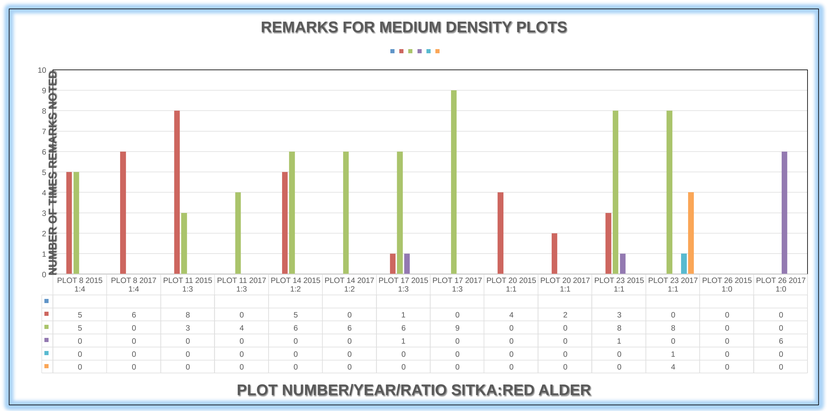
In the medium density plots we are seeing increased damage to the SS in ratio's of 1:1, and 1:0, suggesting that the SS is better sustained in a lower density plot, with a higher ratio of RA to SS. Further investigation needs to be done into whether those results are from density, or temperature decreases due to canopy cover.

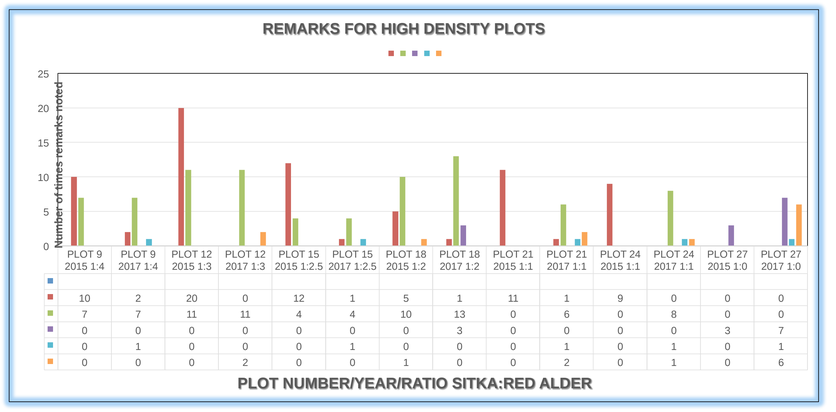
In the high density plots the deaths, forking and top kill are all increased; significantly in the 1:1, and 1:0 ratios. In this density competition for resources, such as water and light may play a significant role in these higher numbers.

Over all in this early data we are seeing better results when we couple low density, with a ratio of 1:3 or greater; this is the better scenario for biomass production. Results of mortality among RA was expected due to competition for resources. Less density would only benefit the RA. Deaths among SS are minimal in all scenarios, but best among the low density, also probably attributed to less competition from competing species. There is definite relation to the ratio of SS and top kill, but what the relationship is needs to be further explored. SS in stands of 1:1, and 1:0 showed more top kill, forking and deaths. Relation of density vs temperature needs to be determined to move forward with research into infestation of the Spruce weevil.

Data







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