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ONRC UPDATE

Director's Message

John Calhoun, Director

This issue of *ONRC Update* focuses on research results from a recent study conducted on spruce-tip weevil infestation in regional Sitka spruce stands. UW ONRC is primarily a research center and includes educational programs, community outreach, and other services as a part of our mix of activities. The core contribution of UW ONRC, however, is to further our understanding of how ecological values can be integrated into the commercial management of natural resources. Scientifically-defensible research and its resulting technology transfer to interested parties is a key to making this happen.

UW ONRC just completed a review of nine outstanding research proposals. We will use designated funds from the USDA Forest Service Pacific Northwest Research Station to support some of these programs of research. We plan to make our funding decisions before the end of April but will not have findings to share with the public for a year or more. We constantly deal with the complexity of the cycle of funding new proposals and communicating results of completed research. The problem is that the subjects we understand to be most critical to fund today may appear much less relevant a couple of years down the road when the results are in. Therefore, there is also an art in making high-need, relevant research project selections today that will result in critical information for tomorrow.

We were pleased that recently the USDA Forest Service reinstated funding for the two previously approved research projects. UW ONRC originally funded these projects last year before the money was withdrawn by the USDA Forest Service to cover firefighting costs. The delay in funding will unfortunately put the projects a year behind in their progress.

The feature article in this issue highlights results of a research project funded by UW ONRC two years ago. Effects of the spruce-tip weevil have plagued spruce plantations on the Olympic Peninsula for nearly two decades. Perhaps you have noticed the twisted dead tops in thick, healthy young spruce trees. Foresters love to plant Sitka spruce in wetter areas after clear cuts because they have a high survival rate and grow fast and vigorously until about age ten to fifteen. But, after ten years of aggressive growth, things start to go wrong for these healthy, vigorous young spruce trees. The spruce-tip weevil attacks and, over a few years, turns the young stand of trees into something more closely resembling a brush field. Needless to say, most of the economic and ecological value expected from a vigorous young forest is lost. The results of this research provides explanations and information adequate to understand what is happening and why. It also provides recommendations on how to avoid the problem.

Luckily in this case, the results of this research may be timely. Thousands of acres of young spruce plantations are just entering the critical age class. Foresters may be aided by these findings as they design silvicultural treatments for these stands.

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OESF Corner

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Washington State Department of Natural Resources

Old-growth Sitka Spruce Tree

The goal of the Olympic Experimental State Forest (OESF) is to learn how to integrate timber production with habitat conservation values, particularly the eventual development of older stands and the restoration of fully functional riparian systems. To achieve this goal, the OESF has a unique mission to implement creative management alternatives through a well-designed program of experimental research. Underlying the mission of this forest laboratory is the applied practice of innovative silviculture as the foundation for operational research.

Recent research funded by UW ONRC (see page 3) on the benefits of growing Sitka spruce under a red alder canopy has shed light on the silvicultural potential of managing even-aged stratified mixtures as a key element in the integrated pest management of the spruce-tip weevil (*Pissodes strobi*). The results of this work leave many questions to be studied.

A controlled effort at applied research is now underway in the OESF to examine a range of silvicultural alternatives for arresting the spread of the spruce-tip weevil. This study will measure the effects of various red alder stocking densities and resulting canopy closures on reducing spruce-tip weevil infestation. These research plots have been established just off Highway 101, 15 miles north of Forks, in the Baby Bear Sanitation Unit.

The Washington State Department of Natural Resources (DNR) has established eighteen square ¼-acre plots at various combinations of three tree stem densities (1200 trees per acre (TPA), 680 TPA, 435 TPA) under three proportional mixtures of Sitka spruce (SS) and red alder (RA) (1:1 RA:SS, 2:1 RA:SS, and 3:1 RA:SS).

In addition, DNR duplicated each of these nine treatments to test the relative benefits of two intermediate thinning options. DNR planted another series of pure spruce plots at three densities (1200 TPA, 680 TPA, 435 TPA) to test the effect of increasing height growth competition on developing greater tolerance to spruce-tip weevil damage by young spruce in pure stands.

Lastly, DNR established a three-level replacement series consisting of Sitka spruce, red alder, and western red-cedar to test the relative benefits of substituting a third tree species for red alder.

DNR will replicate this research installation on a floodplain site to make a paired-sample comparison between responses on upland versus riparian stands. Although there is much data to support stand-level decision-making on upland sites, we know very little about the growth and yield of riparian forests.

Successful innovation in mixed-species stand management is a critical requirement to meet increasing multiple resource demands for improved wood utilization and greater biodiversity on a limited land base in a publicly acceptable manner.

Pure spruce @ 10’ x 10’	Pure spruce @ 8’ x 8’	Pure spruce @ 6’ x 6’	Proportional mix (8’ x 8’) SS = 25% RA= 60% RC= 15%	Proportional mix (8’ x 8’) SS = 25% RA= 37% RC= 38%	Proportional mix (8’ x 8’) SS = 25% RA= 15% RC= 60%
1:3 SS:RA 6’ X 6’	1:3 SS:RA 6’ X 6’	1:2 SS:RA 6’ X 6’	1:2 SS:RA 6’ X 6’	1:1 SS:RA 6’ X 6’	1:1 SS:RA 6’ X 6’
1:3 SS:RA 8’ X 8’	1:3 SS:RA 8’ X 8’	1:2 SS:RA 8’ X 8’	1:2 SS:RA 8’ X 8’	1:1 SS:RA 8’ X 8’	1:1 SS:RA 8’ X 8’
1:3 SS:RA 10’ X 10’	1:3 SS:RA 10’ X 10’	1:2 SS:RA 10’ X 10’	1:2 SS:RA 10’ X 10’	1:1 SS:RA 10’ X 10’	1:1 SS:RA 10’ X 10’

Spruce-tip Weevil Infestation in Sitka Spruce

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UW College of Forest Resources

Sitka spruce (*Picea sitchensis*) is an ecologically vital and economically desirable component of the Pacific Northwest's coastal temperate rain forest. Sitka spruce and its primary pest, the spruce-tip weevil (*Pissodes strobi*), have successfully coexisted for millennia in a unique coastal maritime zone. Sitka spruce has sustained endemic levels of this damaging weevil infestation while maintaining an enormous growth rate. Sitka spruce is the largest spruce on Earth, making it the third tallest tree in the Pacific Northwest.

However, with the advent of intensive single-species plantation management in the 20th century, the spruce-tip weevil population has exploded to epidemic proportions. In fact, it has reached such high levels of infestation that other types of trees are often being used in reforesting harvested land.

Spruce-tip weevils require certain conditions of temperature and humidity for feeding and oviposition (depositing an egg into the tip of the spruce). These activities are inhibited when low temperatures prevail around spruce terminals growing in dense, shaded stands. A Sitka spruce stand cannot sustain viable weevil populations in environments where heat accumulation is insufficient for completion of larval development.

A silvicultural approach to integrated pest management is necessary to allow the continued use of spruce for reforestation and to protect those spruce stands already established but prone to continued damage from weevil attacks. Using hardwood overstory trees, principally red alder, in a mixture with Sitka spruce in the understory, will alter microclimate conditions. This forest prescription could have great value in an integrated pest management program to deter further spruce-tip weevil invasions.

The classic shepherd's crook formed as the result of weevil attack

To evaluate the effect of overstory shade on spruce-tip weevil damage, twenty quarter-acre plots were examined in a 59-acre stand at Merrill and Ring's Pysht Tree Farm. This stand was planted with Sitka spruce in 1986. During the intervening years between 1986 and now, red alder seeded naturally and became a vigorous component in the stand.

An inventory of total canopy closure by all tree species within these research plots included various mixtures of red alder, western hemlock, Douglas-fir, and Sitka spruce. The statistical analysis indicated a poor linear association (r^2=0.0626) of this combination of trees with the incidence of spruce-tip weevil damage.

Dave Powell, USDA Forest Service, www.insectimages.org

Spruce-tip Weevil

However, when all tree species were removed from the model except red alder, compelling evidence of a conspicuous, well-defined degree of linear association between red alder canopy closure and spruce-tip weevil damage resulted in a coefficient of determination of r^2= 0.7494. This means that 75% of the change in weevil infestation could be explained solely by the density of the red alder canopy closure ($p<0.001$).

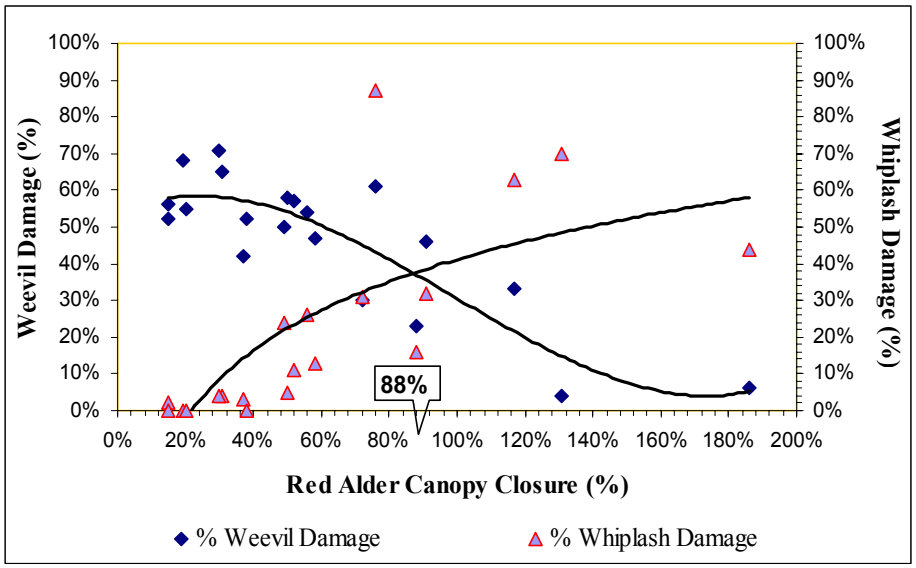
This shows the use of dense red alder overstories may substantially reduce levels of spruce-tip weevil infestation. But this is often at the cost of whiplash damage to spruce terminals by red alder branches as spruce trees attempt to emerge through the red alder canopy. This significantly damages and reduces the growth rate of spruce terminals. It unduly extends the spruce tree rotation period or allows other tree species to outcompete spruce trees. This jeopardizes the longevity and prevalence of the Sitka spruce that have historically stood as one of the largest, tallest, and longest-lived trees, maintaining dominance in the forest canopy.

Proposed management practices should maximize the growth potential of the site by balancing reductions in spruce-tip weevil damage with diminishing the hazard of whiplash damage from red alder, as Sitka spruce begins to replace red alder in the overstory. Superimposed linear trends between the effect of increasing levels of canopy closure on the incidence of spruce-tip weevil attack and progressive whiplash damage intersected one another at 88% level. This means an optimal level of 88% red alder canopy closure will best

Spruce-tip Weevil Infestation (continued)

minimize both weevil attack and whiplash damage to Sitka spruce under a nurse-tree shelterwood system.

The 88% threshold recommended by this research analysis should be thought of as a range rather than a fixed point. This measurement provides direction for



continued investigation of interspecies interactions between Sitka spruce, the spruce-tip weevil, and red alder within the complex dynamics of mixed–species forest stand development.

An optimal level of 88% red alder canopy closure suggests that careful red alder management planning needs to be pursued. The forest manager must consider both the best initial spacing and the intermediate stem spacing density. He or she needs to ensure that an even-aged stratum of red alder provides a thermal barrier to weeviling without becoming a source of whiplash damage during winter storms. This is particularly critical during the period in the stand's development when Sitka spruce are most susceptible to infestation by spruce-tip weevils, approximately between five and twenty-five years of age.

The results of this work leave many questions to be pursued. A controlled and more sophisticated effort at applied research is now underway in the Olympic Experimental State Forest.

There is burgeoning interest in managing even-aged stratified tree mixtures such as red alder and Sitka spruce. Small landowners, in particular, are seeking innovative ways to utilize a smaller land base for multiple and more diverse management objectives. Not the least of these is to shorten the timber rotation and increase the amount of economically desirable red alder. When the red alder is removed, it leaves behind a legacy of well-developed, weevil-resistant spruce trees for further long-term forest growth and expansion.

Developing silvicultural methods that are congruent with the natural ecological compatibility between red alder and Sitka spruce will lead to increased commodity production in an environmentally acceptable manner. This will ensure that Sitka spruce is once again managed as a highly desirable and valuable species for reforestation.

Lyle Almond received his Master's Degree in Silviculture and Forest Protection from the University of Washington College of Forest Resources. Funding support for his initial research investigation was provided by a grant from UW ONRC. Lyle happily lives in the Hoh Valley near Forks surrounded by the Sitka spruce and red alder old-growth forest community that he loves. Lyle can be contacted via e-mail at lylealmond@lycos.com.

Unhealthy and Healthy Spruce Terminal Growing in Abundant Red Alder Trees