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Newsletter of the FFESC project 2009-006: Red Alder Adaptation Strategy

Issue 3, May 2011

Introduction

This is the third issue of a newsletter for the FFESC Red Alder Adaptation Strategy project group. The purpose of this newsletter is to facilitate communication between various research teams within the project, with client groups and with other FFESC project teams. The intent is produce new issues on a semi-annual basis, with updates on progress and significant findings from each of the project teams.

Examining the red alder supply chain in coastal B.C.

Dan Nadir

Red alder is the most abundant hardwood species in coastal B.C. forests. Until recently, it has been viewed as an undesirable species, a nuisance, and even a weed species that should be eradicated to provide for the improved establishment of conifer rotations. Given mounting pressures on British Columbia's forests, attention to the economic and ecological roles of all species – including red alder – is prudent. At a global level, the reality of a changing climate has become a focal point for scientists of many disciplines, and early results from other studies (this issue) indicate that the productive range for red alder could be dramatically expanded. If this is the case, what does it mean to the supply chain that creates hardwood products from BC's coastal forests?



Photo courtesy of Andrew Bluhm, Hardwood Silviculture Cooperative

Alder logs entering a sawmill



Copied with permission from www.bowermans.ca

Custom alder cabinets

Our approach to this question has been to identify the different supply chain actors and to interview them to capture emergent themes and issues related to red alder production. We have been meeting with planning foresters and engineers to discuss the growing of alder stands and to uncover species-specific operational constraints. All operational scales are being included, from woodlot owners through to the larger corporations operating across broad landscapes. In the milling stage of the supply chain, we have been meeting with local processors of red alder (and other hardwood species) to evaluate the health of our current hardwood supply chain and to investigate issues related to the supply and demand for our coastal hardwood products. We are also working with associations that promote the utilization of B.C.'s forest products in the global economy, as well as log brokers and retailers who sell wood products into the existing marketplace. Finally, we are looking to our neighbors to the south and examining their approach to creating a viable hardwood industry in the Pacific Northwest, as we are directly linked to their hardwood supply chain.

Issues related to the most recent economic downturn, the pressures associated with a shrinking US marketplace, product substitution and low-cost manufacturing in developing countries have all been articulated as challenges that face our hardwood manufacturing industry. But there is hope: early results from our study indicate that people are optimistic about the role red alder could play in our future forest industry. Red alder has been hailed for its many uses from toy manufacturing through to providing a large amount of materials to the furniture and finishing marketplace. Overall, it appears that alder could be managed to sustain a small but increased hardwood industry on BC's south coast.

We will be continuing to conduct interviews with relevant supply chain actors and are interested in collecting as many viewpoints as possible. If you would like to contribute your thoughts on the subject, please contact us at daniel.nadir@gmail.com.

Alder and *Frankia* – Nature's Nitrogen Fertilization Specialists

Barbara Hawkins, PhD and Brendan Porter

You have probably observed alder's apparently magical ability to grow in pure gravel. On decommissioned forest roads, alder springs up and grows quickly where few other plants can get a foothold. A major reason for alder's success in this sterile environment is its ability to acquire nitrogen (N) from the air as well as the soil.

Nitrogen is the mineral nutrient needed by plants in the greatest amount. N is an important component of many biomolecules including proteins, enzymes, DNA and chlorophyll. More than half of the N in leaves is associated with enzymes and pigments involved in photosynthesis. Up to 6% of leaf dry weight may be N, but optimal leaf N concentrations are usually 2-3%.

Growth of most trees and plants in cool temperate and boreal forests is typically limited by lack of available nitrogen because only ~0.00025% of soil N is available for plant uptake. A large pool of N is potentially available in the atmosphere, as 77% of the air we breathe is nitrogen gas (N₂). However, this form of N cannot be accessed directly by plants. The only organisms that can utilize N₂ are certain groups of bacteria and cyanobacteria (blue-green algae). These organisms convert N₂ to ammonium in a process called N fixation. N fixation accounts for 90% of new, natural N inputs to the biosphere.

Other soil microbes and plants largely depend on the ammonium synthesized by N-fixing organisms.

Nitrogen fixing organisms may be free-living in the soil or on plant surfaces. A few groups of N-fixing organisms have evolved symbioses with plants (including alders and the legume family) where the host plant provides protection and carbohydrates, and gets a useable form of N in return. A major challenge for N-fixers is that their key enzyme, nitrogenase, is inhibited by oxygen. Some free-living N fixers circumvent this problem by living in anaerobic (oxygen-free) environments, others make special oxygen-proof cells where N fixation can continue. Symbiotic N-fixers live inside nodules that develop on the host plant's roots and exclude oxygen. Alder's nodules can be found within 10 cm



Alder root nodules containing nitrogen fixing bacteria - each cluster is approximately 2 cm in width.



Brendan and Sarah measuring rates of nitrogen fixation near Bowser on Vancouver Island.

of the soil surface as orange, coral-like structures up to 5 cm in diameter (top photo, previous page).

Alder's association with its N-fixing bacterial symbiont, *Frankia*, gives it a competitive edge over other plants. This is one of the characteristics that make alder a weed in the eyes of many people. Alder can provide benefits, however, as the new N it brings to an ecosystem is recycled and taken up by other plants, including conifers. If we choose to plant alder for its direct and indirect benefits, we may want to plant alder families with the highest rates of N fixation.

Just as known genetic variation exist among tree families in traits such as height growth, time of bud flush and cold hardiness, genetic variation in rates of nitrogen fixation can be expected among alder families. In studies of N-fixing crop plants, genetic variation has been shown for nodule numbers and mass, speed of nodulation, and nodule N accumulation. Genetic variation may also exist in the efficiency of N fixation by different strains of *Frankia*. Our project is exploring the alder side of the symbiotic relationship by comparing nodule density and rates of N fixation in 50 families of alder planted on two contrasting sites. Early results indicate that families differ in nodule density but not in rates of N-fixation per unit nodule. Sampling of leaf N concentration and tree size will allow us to infer if differences in rates of N fixation lead to greater growth or N content in plant tissues. Our results will allow alder aficionados to choose alder families best-adapted for growth and high rates of N fixation.

Sources:

- Graham, P. H., Hungria, M., and Thusty, B. 2004. Breeding for better nitrogen fixation in grain legumes: Where do the rhizobia fit in? Online. Crop Management doi:10.1094/CM-2004-0301-02-RV.
- Miller, A.J. and Cramer, M.D. 2004. Root nitrogen acquisition and assimilation. Plant and Soil. 274: 1-36.
- Taiz, L. and Zeiger, E. 2010. Plant Physiology. Fifth Edition. Sinauer Assoc. Inc.

Intensive Management of Red Alder in Washington and Oregon

Craig Farnden, PhD RPF

The manufacture of high value lumber from red alder is a vibrant industry in the US Pacific Northwest. Solid wood products have fewer commodity-like attributes than do those produced from softwoods, and are less affected by the notoriously cyclical price fluctuations of lumber

markets. In recent years, much of this industry has been based on harvests of alder as a secondary species in conifer-dominated stands, but overall growing stock levels for the species are declining. Aggressive vegetation management practices in conifer plantations are at least partly to blame, as are species conversions and conversions of good alder growing sites to real estate. In the future, it is expected that a large proportion of the alder supply will come from intensively managed alder plantations, although the vast majority of these are currently less than 25 years of age.

Intensive management of red alder is viewed as an attractive financial investment opportunity by many forest land managers on both private and public trust lands in Washington and Oregon. Over the last 5 to 10 years, red alder values have exceeded those for Douglas-fir, and some economic analyses have indicated far higher returns on investment. Given potential shortfalls in future log supplies, the future for growing red alder looks very good.



Fifteen-year old alder on Hardwood Silviculture Cooperative plots near Scappoose OR, planted at 1600 trees/ha. The bottom plot has recently been thinned to 533 trees/ha.



Fifteen-year old alder on Hardwood Silviculture Cooperative plots near Scappoose OR, planted at 3658 trees/ha. The bottom two plots were thinned at age 9 to 305 and 560 trees/ha respectively.

Achieving good returns from alder management requires careful attention to a number of factors, the first of which is site selection. Red alder is considerably more sensitive to site quality than is Douglas-fir, and an economically significant performance advantage is achieved only on the best sites. Model-based guidelines currently employed by the Washington State Department of Natural Resources suggest minimum site index values of 60 ft (total age 20) or 27 m (breast height age 50). Ideal sites typically occur at elevations below 100 m on deep, fine textured soils with minimal growing season moisture deficits. It is also very important to avoid frost pockets.

For financial investment purposes, alder is grown on a 30 to 35 year rotation. Planting densities are relatively high (1300 to 1700 trees/ha) to promote straight growth with minimal forking. The quality of the bottom log, which is dramatically impacted by forking and branch size, is of critical importance to capture the full economic potential of each tree. Early thinning is then critical to help maintain diameter growth, with the timing being dictated primarily by the rate of self pruning. A live crown ratio of 50 to 60% has been suggested as an ideal target, which typically occurs at ages of 5 to 9 years depending on the establishment density. Late thinning can result in significant height losses, as individual tree growth for red alder is quite sensitive to reductions in crown volume induced by early crowding.

In some cases, pruning is being investigated as a way to further increase product values, but the jury is still out on the final outcomes. The Hardwood Silviculture Cooperative, headquartered at Oregon State University, has plans to evaluate economic returns from pruning by tracking logs from a set of experimental plots (pruned and unpruned) through a sawmill to track lumber grade recovery rates. Additional information will also be forthcoming from such experiments on the benefits of commercial thinning entries.

The old attitudes that considered red alder purely as a weed are slowly disappearing. Increasingly, the species is gaining the recognition it deserves as a valuable component of west coast forest investment portfolios. This does not mean that its days of being killed in favour of conifers are completely over. Appropriate deployment of tree species to the correct selection of sites will always be an important consideration for every forest land manager.

***Note:** Information in this article is based on presentations and field tours at the Joint Washington/Oregon Society of American Foresters Meeting, May 12-13, 2011.*

Project Update: Mapping Climate Envelopes for Alder

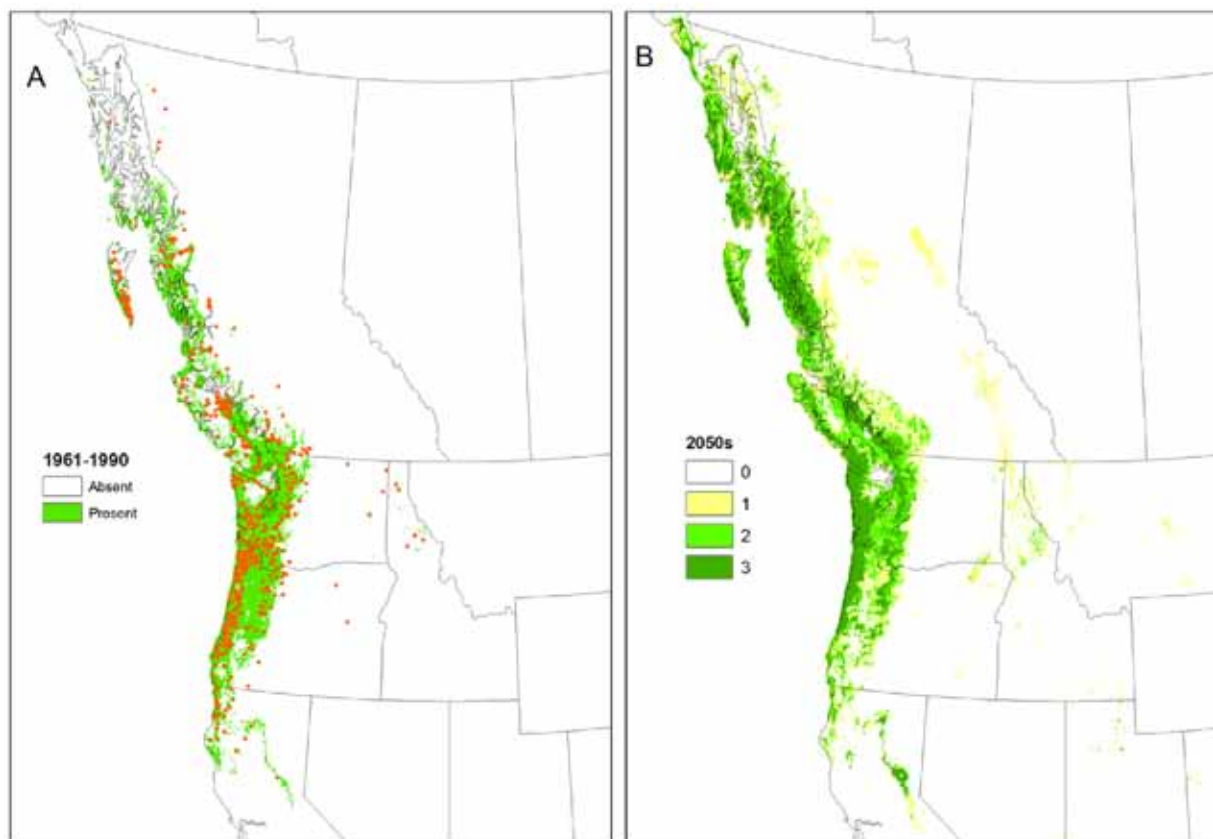
Tongli Wang PhD

Under a rapidly changing climate, modeling the suitable climate range (or bioclimate envelop) of a species and projecting it into future periods are critical steps for scientists and forest managers in developing adaptive management strategies. In the first issue of *Aldern*, we introduced some of the key concepts of bioclimate modeling, and highlighted some of the changes to climate variables affecting plant species ranges that could occur. In this issue, we are exploring some of the potential outcomes that can be predicted for the range of red alder.

Our approach to bioclimate mapping requires three elements: i) species presence-absence data to represent the realized climatic niche of the species, ii) high-resolution climate variables that reflect detailed climatic conditions where the species is present or absent, and iii) a powerful modeling approach that can effectively mimic relationships between species occurrence and climate variables.

Species range data for BC were determined using ecological plot data from the BC Ministry of Forests, Lands and Natural Resource Operations, and for the US using Forest Inventory and Analysis (FIA) data. High-resolution local climate variables were generated using the ClimateWNA model. Climate variables for the 1961-1990 normal period were used to develop the bioclimate envelop model, while the predicted climate data for future periods (2020s, 2050s and 2080s) were used to project the future geographic distributions of the bioclimate envelope based on three different climate change scenarios. The climate envelope model based on species-climate interactions was developed using Random Forests™, a powerful machine-learning method of classifying complex relationships.

A strong relationship between species occurrence and climate variables was established using the Random Forest model. The mismatch rate (the inverse of model accuracy) was only 8.5%, as estimated using a portion of the original dataset reserved for validation. Predicted bioclimate envelopes for the reference period (1961-1990) and



Distributions of sample plots with red alder present and bioclimate envelopes predicted for the reference period (1961-1990) (A) and projected for 2050s using three climate change scenarios (B). The numbers in B indicate the level of model agreement (0 – 3).

the 2050s are illustrated on the previous page, along with locations of the calibration sample plots. We found that the bioclimate envelope for this species would be substantially expanded northward along the coast and towards interior, suggesting a much greater area suitable for planting red alder in British Columbia in the future.

For the Campbell River Forest District, we generated climate data at a very high resolution (90 x 90 m) for the initial reference period (1961-1990) and for the three future periods (2020s, 2050s and 2080s) and the same three climate change scenarios as above. Our projections demonstrate a general increase in areas suitable for red alder to grow in this Forest District (see below) with good model agreement. However, projections differed substantially among the three climate change scenarios.

Project Group Team

The following individuals make up the team that is delivering the FFESC Red Alder Adaptation Strategy:

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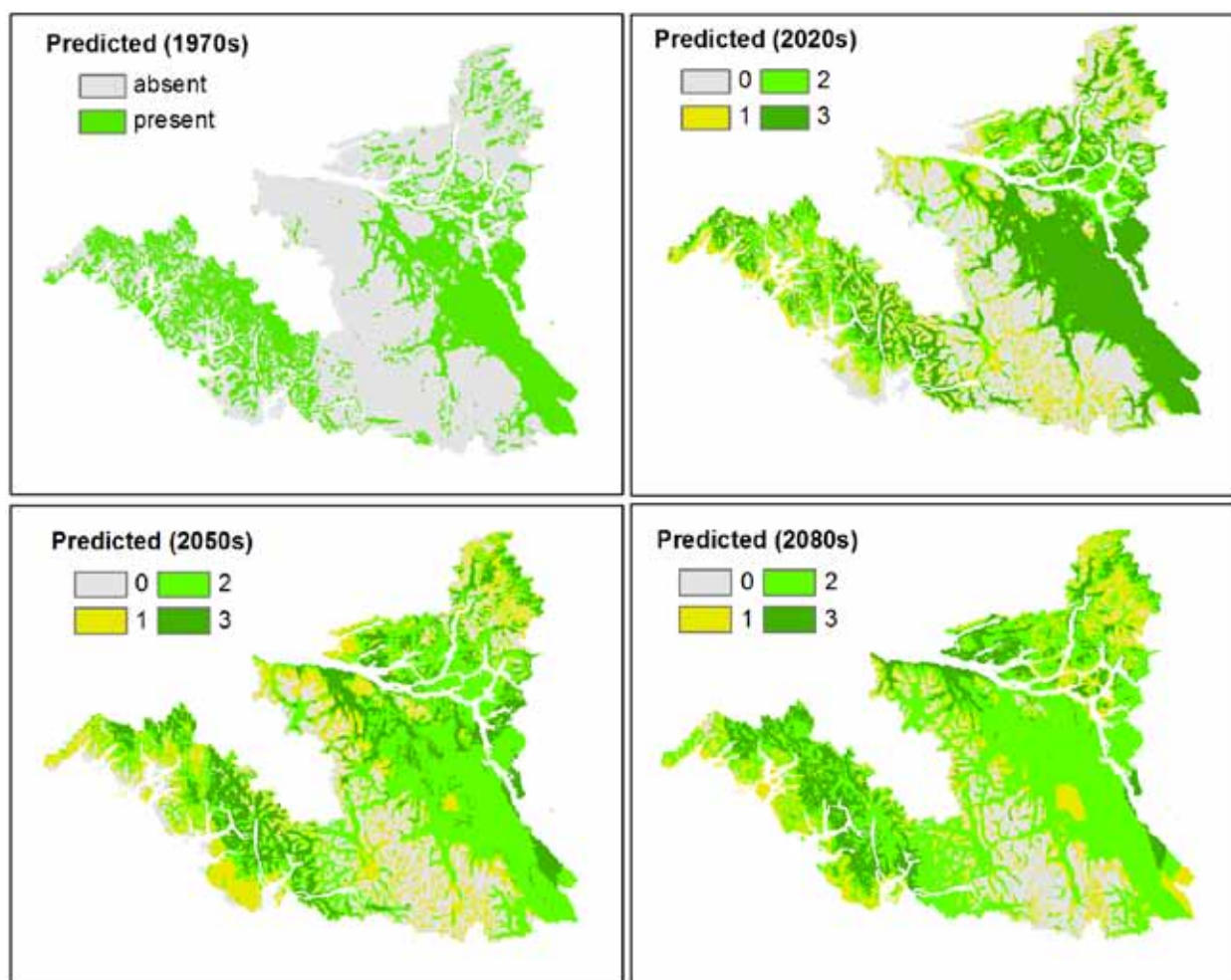
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Maps of the bioclimate envelope of red alder in the reference (1970s) and future periods (2020s, 2050s and 2080s). The numbers in the figure indicate the level of model agreement (0 – 3).

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