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Newsletter of the FFESC project 2009-006: Red Alder Adaptation Strategy *March 2010*

Welcome

This is the first issue of a newsletter for the Future Forest Ecosystems Scientific Council (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.

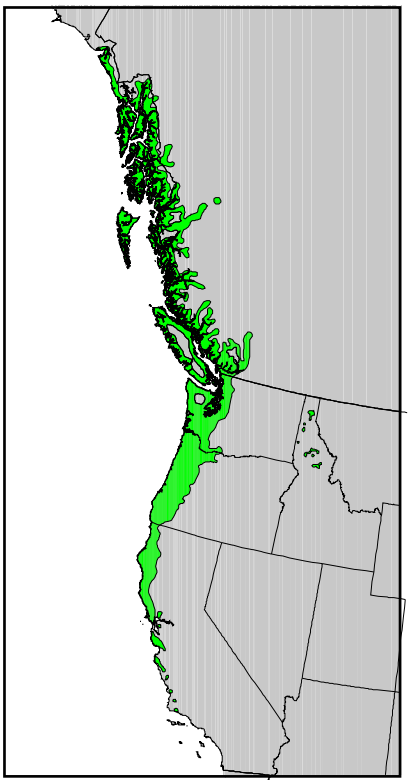
The name of this newsletter, *aldern*, is an archaic word meaning "made from alder". This could be taken to infer products made from alder, both modern and traditional, but it could also suggest the body of knowledge that comes from studying the species.

The Red Alder Adaptation Strategy

The red alder adaptation starategy is a collaborative project amongst researchers at UBC, UVic, the University of Alberta, Oregon State University and the BC Ministry of Forests and Range. The overall objective is to blend biological, ecological and socioeconomic knowledge gained about red alder to create an adaptation strategy for reducing environmental, social and economic risks of climate change in coastal B.C.

Red alder is the most common broadleaf tree on the northwest coast of North America, with a range stretching from coastal southeast Alaska to southern California (see map at right). Inventory estimates for red alder in B.C. are 91.9 million m^3 for all stand types and 29.7 million m^3 for alder-leading stands. In response to climate change, red alder is expected to increase in frequency and expand its distribution in B.C. This expansion is supported by records of abundant red alder pollen in the north Cascades between 9000 and 4800 BC when the species mix of that time indicates a warmer climate accompanied by an increase in fire frequency. Red alder can be grown both as a short rotation, high value crop and in mixedwood plantations, providing a diversity of wood products and good return on investment. Red alder is relatively short-lived, maturing at about 60 to 70 years. In pure stands on good sites, red alder can achieve mean annual growth rates of 21 m^3/ha/yr in pulpwood rotations of 10 to 12 years, and 14 m^3/ha/yr in sawlog rotations of 30 to 32 years.

In some conditions, alder plantations can provide better return on investment than Douglas-fir plantations. Hardwood markets tend to be less cyclical than commodity-driven softwood markets and the use of alder in the manufacture of value-added wood products means that demand is secured by niche-product positions with little risk of substitutions. In the U.S., red alder has become an economically important species in recent times with value-added hardwood exports steadily increasing from 1986 to 2002, providing a growing marketplace for North American businesses. Red alder exports to China increased by 62% between 1995 and



Current distribution of red alder.
Source: USGS and USDA Forest Service at http://esp.cr.usgs.gov/data/atlas/little/

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2002 and were the top hardwood export to China in 2002. Pure and mixed alder plantations can provide a wide range of forest products, from cheap biofuels to valuable sawlogs. For forest-dependent communities, jobs can be created through intensive management of alder and mixed-wood plantations.

There are a number of information gaps that must be addressed before overcoming barriers to the increased use of red alder on the coast. In order to recommend best management practices under a changing climate, more information is needed regarding: (i) the effects of red alder densities on conifer and mixedwood stand development and the influence of site factors and climate change on these interactions, (ii) red alder's ability to adapt vs. acclimate to changes in climate, needed for family selection for red alder tree improvement and planting programs that will be acceptable over the next 40 to 60 year period, (iii) the geographic extent of red alder productivity in the future with respect to the expected migration of alder to sites that are currently too cold for alder survival and growth, and (iv) the socioeconomic implications of short-rotation red alder and mixedwoods plantations across the landscape. This study proposes to use a multidisciplinary, collaborative approach to address these information gaps. The synthesis of biological, ecological and socioeconomic information generated by collaborators in this project will result in the blueprints for an adaptation strategy to reduce environmental, social and economic risks of climate change in coastal B.C.

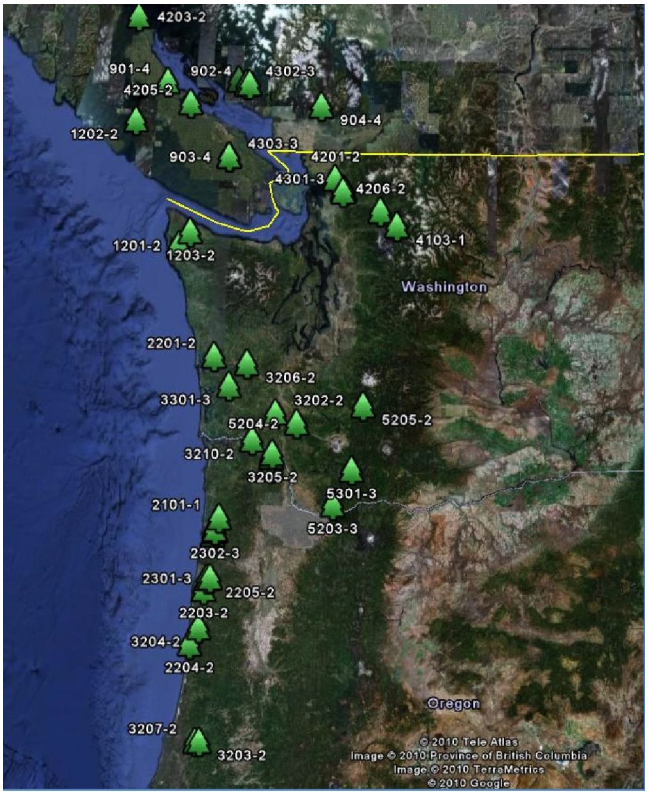
Specific questions that form the basis of five study areas to be addressed in the project include:

1) What are the effects of climate, age, soil and latitude on growth of red alder and Douglas-fir and the interplay between climate and competitive vs. facilitative effects of red alder?
2) What is the range of adaptation vs. acclimation in alder's response to variation in climate?
3) Where can alder be planted today that minimizes risk from climate change and maximizes benefits to forest-dependent communities including First Nations?
4) What traditional knowledge can First Nation elders provide that will help us to learn about the potential for future cooperative management of alder in the case study area?
5) What steps need to be taken to develop an integrated hardwood forest sector value chain industry on the coast?

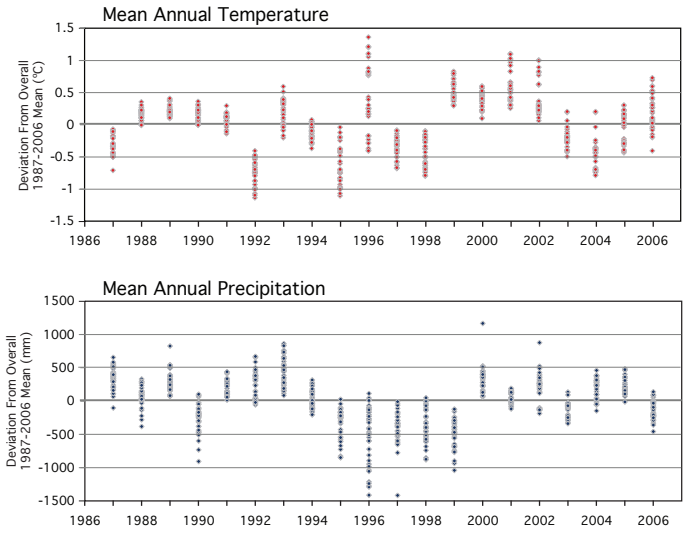
Project 1: The Growth Environment of Red Alder and Douglas-fir

In the Pacific North West red alder is a common early successional species on sites that have experienced major disturbances such as clearcutting, fire or landslides. While alder often competes with regenerating conifers, it can potentially enhance their growth by increasing nitrogen availability. Of particular interest are the effects of latitude, climate, soil, and age on the growth of red alder and Douglas-fir, and the interplay between climate and competitive vs. facilitative effects of red alder.

This study will use existing data from long term trials that cover a broad latitudinal gradient from central Oregon to southern B.C. (see image below). These research sites were established starting in 1989 by the B.C. Ministry of Forests and Range and the Hardwood Silviculture Cooperative in the US. Over the next two growing seasons we will collect additional soil and foliar nutrient data from several of these sites. ClimateWNA software will provide climatic information for each year since establishment.



Locations of alder research installations.



Sample of two climate parameters illustrating variation by location.

Effects of climate (e.g. temperature, precipitation) during both the current and preceding year on growth of red alder and Douglas-fir will be examined using regression techniques. Soil and foliar nutrient data will be used to examine effects of soil nutrient availability, soil drainage class, and foliar nutrient content on interactions between red alder and Douglas-fir.

These relationships will then be used to estimate potential effects of climate change on the growth of plantations of these two species during the first 15 years following establishment. Variations will be evaluated based on available scenarios of future climate.

At this stage of the study we have generated the climate data for the period 1987-2006 for the 41 sites. We have applied for permits to import soil and foliage samples from the USA and hope to begin sampling in late April.

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Project 2: Alder Adaptation vs. Acclimation to Changes in Climate

There are two different strategies used by organisms to best utilize the environment within which they find themselves: acclimation and adaptation. Individual organisms have a fixed range of genetic variability from which to draw in order to alter their physiology or the structure and function of newly grown tissues to cope with changes in the environment. Such expression of existing genes by an individual is termed acclimation. Over many generations, evolutionary processes come into play whereby the range of genetic variability shifts. Genes that have become advantageous in new or altered environments become more prevalent, while those that are less advantageous wane. This second strategy is termed adaptation.

Over red alder's geographical range, significant adaptation to local climates is expected, and genetic variation has been demonstrated over latitudinal ranges, within river drainages in Washington and Oregon and between island and mainland populations in BC. Adaptation to local environments and significant genotype by environment interactions and have been observed in red alder at both the population and family levels. With changing climates, however, local adaptations may become less advantageous. In addition, the expected response of red alder to mixed planting with conifers at one latitude may not be directly transferrable to provenances from another latitude as climates warm.

We have identified 25 environment-sensitive and 25 environment-insensitive families within the Ministry of Forests and Range red alder breeding program. These assessments are based on changes in rank by height and diameter in two contrasting environments. We will explore physiological mechanisms underlying the ability of these families to acclimate vs. adapt to variation in climate. We will assess how the effects of climate on the competitive interactions of red alder and Douglas-fir revealed by our collaborators may be further affected by genetic differences in family acclimation ability.

Genotype and environmental variability in growth, phenology, water use efficiency, cold hardiness and N2 fixation will be quantified in the 50 families planted in 15-year-old provenance/progeny trials in contrasting climates near Bowser and Terrace. Bud flush began in early March at the Bowser site and timing of bud flush in the 50 families is being recorded. Bud flush at the Terrace site will be assessed in mid-April. Nitrogen fixation rates will be estimated over the summer using two methods.

Brendan Porter and Barbara Hawkins on the Bowser field site.

Cold hardiness assessment and sampling for stable carbon isotope analysis to determine water use efficiency will be done over fall and winter.

Results will allow us to interpret red alder's adaptation vs. ability to acclimate to differences in climate. We will assess if all families show the same response in phenology, water use efficiency, cold hardiness and N fixation to the warmer, drier Bowser climate (adaptation) relative to the Terrace site, or if there are genotype x environment interactions where some families have a greater or lesser ability to acclimate to contrasting climates. We expect the latter situation, and we will then work to interpret the physiological mechanisms behind this climate sensitivity. Recommendations will be developed for family selection for red alder breeding and planting programs.

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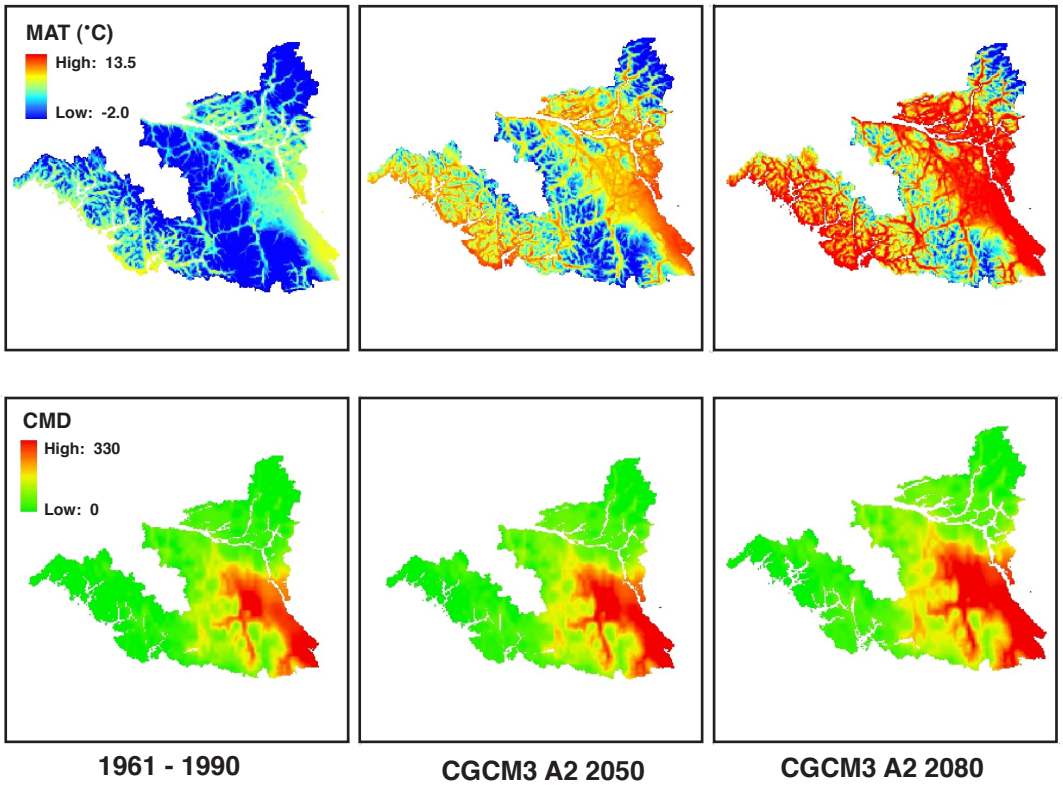
Project 3: Mapping Climate Envelopes for Alder

Uncertainty around climate change is an important concern for forest managers. The range of climatic conditions that is suitable for a tree species can be termed as its climatic envelope, and these conditions are expected to shift geographically as the global climate warms. Knowledge of potential shifts is critical for effective management of future forest conditions.

Determining the climatic envelope for a tree species requires (i) a range map for the species based on data such as forest inventories and (ii) high resolution mapping of climatic variables such as mean annual temperature, seasonal temperatures and patterns of precipitation. The latter task is achieved using computer software such as ClimateBC and its successor ClimateWNA (western North America). These programs extract and downscale gridded 2.5 x 2.5 arcmin (approximately 4.5 km x 3.0 km at 49º N latitude) monthly climate data for the reference period 1961-1990, and calculate seasonal and annual climate variables for specific locations based on latitude, longitude and elevation (optional) in western North America. The programs also downscale and integrate historical and future climate datasets (e.g. 2020s, 2050s or2080s) generated by various general circulation models (GCMs). The output includes both directly calculated and derived climate variables.

For the Strathcona Timber Supply Area (TSA), we had originally planned to generate gridded climate data at 200 x 200 m resolution. After re-evaluation of the number of data points and computing capacity, it was decided to generated climate data at a higher resolution (90 x 90 m) for the initial reference period (1961-1990) and two future periods (2050s and 2080s) with three GCM climate change scenarios. Two of them (CGCM3 A2 and HadCM3) were recommended by the Pacific Climate Impacts Consortium and one (CGCM3 B1) is consistent with agreements from the 2009 Copenhagen Climate Change Conference, i.e. global mean annual



Examples of potential change in climate parameters over time for the Strathcona TSA. The top row represents three discrete decadal time periods for mean annual temperature (MAT), while the bottom row illustrates the same for mean annual water deficit.

temperature not to exceed 2°C. High-resolution climate data have been generated for 15 often used climate variables (see mapped examples on next page).

There are two options in projection method. One is to use a Biogeoclimatic Ecosystem Classification (BEC) variant-based approach, which associates the distribution of red alder with predicted shifts of BEC variants. Another option is to model the climate niche of red alder based on ecological plot data, which will provide a higher resolution for the projections. However, the latter method is still in process of calibration. This part of the work has therefore been postponed to next fiscal year and is expected to be finished before the summer of 2011.

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Note:

The ClimateWNA software has been officially released at: http://www.genetics.forestry.ubc.ca/cfcg/ClimateWNA/ClimateWNA.html

Project 4: First Nations Traditional Knowledge

To understand how an increased presence of hardwoods might affect forests of tomorrow, it is useful to look at historical trends. One way to do this is to collaborate with First Nations Elders that have an oral history that can span thousands of years. Their history could also include how the hardwoods (specifically red alder) might have been managed and used in previous times. We will document First Nation Traditional Ecological Knowledge regarding biological and growth characteristics of red alder during much earlier times (thousands of years) when the climate was different than today. We will also document discussions with First Nation natural resources departments regarding future cooperative management of red alder and it's current use or value to communities.

Research with the First Nations elders will be structured around respect between both parties involved. This project will employ a Participatory Research (PR) and Reciprocal Learning (RL)

approach to working with First Nations in and around the Strathcona TSA. Such an approach is important when working in a small, tightly connected community. PR is research by and with a community, rather than simply for or about a community. PR fosters representation and helps find solutions that draw from the perspectives of participating individuals and group representatives affected by potential actions generated within the research. Oral histories of red alder obtained from the Elders will need to be respected as intellectual property such that they have a right to decide how that information is disseminated to the broader public.

Currently the most important item is to set up a number of preliminary meetings with First Nation band managers, band councils, or regional committees comprised of multiple bands to introduce the research question and address any concerns. This will be an important step in ensuring that the ethics component of the study will be adequately addressed as well as ensuring that the participatory and reciprocal learning approaches are being employed.

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Project 5: Supply Chain Analysis

It is anticipated that increased commercial utilization of alder in the near future my provide valuable opportunities for small businesses and forest-dependent communities. This project will use available information about red alder markets and the information generated in Project 3 to create scenarios for economic evaluation that will allow us to better understand the future benefits of actively managing his species. From this, we will recommend steps to develop a red alder value chain for coastal British Columbia that is economically sound, sustainable, and respectful to First Nations. On this latter point, we will focus on the viability of business ventures and partnerships.

The value chain question will be explored by first conducting a thorough literature review to compile the most recent and relevant information about red alder opportunities. This will be followed by a series of regional focus group sessions to elicit valuable, qualitative information from relevant stakeholders in the Strathcona TSA. Next, structured interviews and questions will be arranged based on information gained through the focus groups. After collecting the most relevant information and conducting the focus groups, a business case will be developed that will deal with both spatial and temporal concerns generated by the preceding research steps.

This research is currently in the formative stage. Preliminary meetings with some regional players on Vancouver Island are currently being set up. Considerable effort is also being put toward ensuring that all aspect of interactions with community and industrial partners meet rigid ethical standards. Free and informed consent is an important aspect of the research and will be obtained before any formal interviews take place.

Any interested parties are encouraged to contact the research team to become involved in the exploration of the supply chain question.

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Photo: George Harper