Executive Summary

Project:

FIA-FSP Y09-2200: Assessing ecosystem vulnerability to climate change from the tree- to stand- to landscape-level

Project Purpose and Management Implications:

The Future Forest Ecosystems Initiative (FFEI) is researching how to adapt forest and range management to climate change. The initiative has outlined six objectives for adapting British Columbia's forest ecosystems. The first two objectives relate to understanding the functional constraints for key species and ecological processes and how these species and processes may be altered over time as climate changes. The objectives of the FFEI have been designed to facilitate our understanding of ecosystem processes and responses to climate change so that adaptation strategies can be developed that enhance ecological resilience and ecosystem services. Understanding species response and vulnerability is an important step if we are to determine where, and what, adaptation strategies are to be incorporated into long-term forest planning and risk management in relation to climate change. To provide this understanding we are assessing the vulnerability of the Sub-Boreal Spruce (SBS) ecosystem in the Bulkley Valley region of north-western British Columbia to climate change from the tree to landscape-level. Management actions that maintain or expand the resilience of an ecosystem to shifts in climate are required if ecosystem functionality is to be sustained. To determine how to maintain ecosystem resilience an understanding of ecosystem vulnerabilities is required. Gaining this understanding is an important step if we are to determine where and what adaptation strategies are to be incorporated into long-term forest planning and to providing guidance on how to manage for the risks associated with climatic change. The ability to achieve a sustainable forest industry will rely on our understanding of ecosystem vulnerability to climate change. Identifying changes in climatic suitability for species and any loss of species resilience has many management implications in regards to reforestation policies surrounding current and future species selection within the region. Changes in inter-species competition and disturbance regimes will impact how ecosystems will develop which in turn will impact the type and intensity of silviculture we practice. Our objective of this study is to provide an understanding of ecosystem vulnerability to inform policy and management adaptation in a manner that will foster ecological resilience not hamper it.

Project Start Date and Length:

Three year project that started April 1, 2007. We have currently completed Year 2 of this project on March 31, 2009.

Methodology Overview:

We are using a meta-model framework to conduct a vulnerability assessment on the potential impact climate change will have on a forest ecosystem within the Bulkley Valley. The driving models that will assess climate change vulnerability are TACA and SORTIE-ND. TACA is an individual tree response model that was developed for evaluating the vulnerability of tree species to climatic change within a species regeneration niche. SORTIE-ND is being used to model stand-level dynamics. SORTIE-ND is a spatial-explicit individual tree growth model which over the past 10 years has been significantly developed, parameterized and validated as a growth model for northern BC. The changes in regeneration potential identified by TACA are being used to drive the establishment parameters of SORTIE-ND under climate change. The assessed changes in soil moisture conditions on three edaphic sites by TACA are also being used as input into SORTIE-ND to model the potential effect of site type change on the growth rates and competitive interactions between assessed species. The ecological modeling is linked to data collected at established field sites within the study area are used to investigate how competition changes across nutrient and moisture gradients. To model natural disturbances three models will be used. Three existing models will be used and one will be developed. To model fire, the Canadian Forest Fire Behaviour Prediction (FBP) System will be used to parameterise the landscape simulation model of Mathey et al. (2008) which will then spatially model fire spread; for bark beetles, the Canadian Forest Service Mountain Pine Beetle Risk Rating System (CFS MPB RRS) will be utilised. The third model will be a Dothistroma Risk Rating System that is being developed as part of this study.

Project Scope and Regional Application:

Adapting our forest ecosystems to climate change can only be accomplished by gaining an understanding of species and ecosystem response. Currently we are unable to predict the exact response of ecosystems to climate change. We can however increase our understanding of potential species and ecosystem response and use these as a management guide. By integrating the results into an adaptive management strategy we can bridge the knowledge gap between reactive and proactive forest management. This project could help managers engage in proactive management actions that in turn will increase our ability to mitigate the future risks associated with projected climate change. This type of research seeks to gain a multi-scale understanding of ecosystem vulnerability to climate change. This is an essential foundation for identifying future risks to the achievement of sustainable forest management. The project is focused on the Sub-Boreal Spruce ecosystem in the Bulkley Valley, the regional focus will not allow the results to be transferable but the methodologies will be.

Interim Results and Conclusions from Year 2:

This report represents the accomplishments during the fiscal year, ending March 31, 2009. In Year 2, the TACA model was improved and the assessment conducted again with similar findings as Year 1 but with species responses predicted to be less extreme then in the initial modelling. The results of the Year 1 & 2 TACA modelling were integrated into SORTIE-ND. The linkage of the two ecological models allowed for the interactive effects of climate, competition, disturbance type, and changes in resource availability (moisture, substrate, and light) for assessing the response of four dominant tree species in the sub-boreal forest of the Bulkley Valley. This study found that climate change may reduce soil moisture availability which may resulted in a decline in regeneration potential for all species on dry sites and negative to neutral responses on mesic to moist sites. Stand dynamics and composition where also predicted to undergo significant changes under the 2080s climate compared to current climate conditions. Species response was found to be exacerbated following fire particularly on dry to mesic sites with lower intensity bark beetle disturbances mediating the response of interior spruce and subalpine fir. Site type also had an influence in interaction with disturbance type with the site with the highest moisture availability maintaining the same stand dynamics and composition following bark beetle disturbances under climate change. This study highlights the need to consider species response to climate change in interaction with existing stand conditions, disturbance type, competition, resource availability, not just climate. The results of this years project work were presented at an international conference, Plant Responses to Air Pollution and Global Change Symposium held in Creswick, Australis in December 2008 and at a Future Forest Ecosystem Initiative Seminar held in Victoria on February 5, 2009. This latter seminar was conducted in lieu of the proposed Timber Growth and Value Conference presentation since this conference was not held this year by the BVRC.

Work on the impact of climate change on disturbance agents also continued this year. We conducted an extensive statistical analysis of the *Dothistroma* and climate interactions in order to test the utility of the *Dothistroma* risk rating model conceptualised in Year 1. This analysis identified that within the Bulkley Valley, climate change may result in a shift in the phenology of dothistroma reproduction from the summer to the autumn. The analysis identified that summer conditions may become unfavourable for continual dothistroma reproduction but the autumn may increase in favourability for this foliar diseased. Overall, dothistroma risk may not change as dramatically as the Year 1 analysis suggested though the shift in seasonality may allow for continual increases in Dothistroma needle blight disease incidence over the next 30 years. Further research is required to examine what the implications of a potential shift in *Dothistroma* reproduction phenology from the summer to the autumn and potentially the spring.

Contact Information:

Dr. Craig Nitschke
Bulkley Valley Research Centre
crnitschke@gmail.com