Progress Report for Future Forest Ecosystem Initiative Project:

Regeneration Vulnerability Assessment for Dominant Tree Species throughout the Central Interior of British Columbia

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Project Overview

In this study, we are focussing on understanding the response of the dominant tree species within their regeneration phase in the ecosystems of the central interior of British Columbia to predicted climate change. The ecological model, TACA (Tree and Climate Assessment) (Nitschke and Innes 2008), is being refined and parameterised for use in the ecosystems of the Central Interior of BC. TACA is being used to conduct a vulnerability analysis on the impact of current and future climates will be used to test the range of species' responses across the Central Interior of BC. Climate data from around the central Interior is being used to generate the climate scenarios as well as climate change predictions from the Pacific Climate Impacts Consortium (2009). Soil data from long-term BEC plots is being used to parameterise the soil component of TACA. The year one deliverables for this project is to provide an interim report on project progress.

Project Progress

The first year of this project ahs been spent on further model development to improve the ability of TACA to model species response. Working closely with researchers from the MOFR and Canadian Forest Service has lead to refinements of the model and initial testing. This was completed in autumn 2008. The project work over the last year has primarily focussed on organising data sets to parameterise the mode. Relevant climate stations were identified for each subzone (where possible) and the data downloaded from Environment Canada. Climate change data is being downloaded from the Pacific Climate Impacts Consortium (2009) on a station by station basis. This permits us to use regional projections of climate change to cover the entire spatial context of the SBS zone. Data for the parameterisation of the soil component of the model has been collected from the MOFR and is being analysed on a subzone level to provide model parameters that represent different edaphic moisture conditions. To test initial model parameters and proposed methodology initial modelling has also been completed this year for portions of the SBSdk, SBSmc2, and SBSwk2. The following sections highlight in more detail the work that has been accomplished to date in this project.

Ecological Model Refinement

The ecological model, TACA (Tree and Climate Assessment) (Nitschke and Innes 2008), was modified and parameterised for use in the Sub-Boreal Spruce (SBS) ecosystems of the province. TACA is a mechanistic model that analyses the response of trees in their fundamental regeneration niche to climate-driven phenological and biophysical variables. It conducts a sensitivity analysis to determine the probability of species presence under a range of climatic and edaphic conditions. The modelling of species presence reflects the fundamental regeneration niche of a species, because presence is directly related to establishment (McKenzie et al. 2003). The original TACA model developed by Nitschke and Innes (2008) was modified to incorporate a frost free period mechanism. Hamann and Wang (2006) found that the annual number of frost days had a significant interaction with observed species ranges in BC. The phenology component of TACA was also improved to increase the interaction between chilling, heat sum accumulation, frost, and budburst base on Bailey and Harrington (2006). Previous interaction in the model was limited to the accumulation of a heat sum without considering chilling period length and frost effects during this stage and then frost damage occurring after bud burst. The new phenology component integrates the obtainment of a species chilling requirement with the accumulation of it heat sum which then interacts with frost events that delay bud burst and/ or causes frost damage after bud burst occurs. The soil moisture function was upgraded to the full Penman-Monteith equation (McNaughton and Jarvis, 1983; Waring and Running, 1998) which is driven by estimates of daily solar radiation based on calculations from Bristow and Campbell (1984) and Ferro Duarte et al. (2006). In addition the soil component of TACA was expanded to allow for three different soil types (texture and depth) to be run simultaneously allowing for the representation of multiple edaphic conditions commonly found within forest ecosystems.

Model Parameterisation

Climate Parameters

Multiple scenarios of current and future climates are being used to test the sensitivity of species' responses. In modelling climate, we are utilising local climate data and global climate change model (GCM) predictions. A direct adjustment approach is being used to integrate climate change scenarios into the historical climate records for 40 climate stations that represent the SBS subzones (Table 1). A direct adjustment approach was used by Hamann and Wang (2006) and Nitschke and Innes (2008) to model species response to predicted climate change. Three different GCMs are being used, the Canadian GCM2 (Flato et al. 2000), Hadley CM3 models (Johns et al. 2003) and the CSIROmk2b. The regional climate change predictions for the SBS zone are being obtained from the Pacific Climate Impacts Consortium (2009). Multiple climate scenarios are generated following Nakicenovic et al. (2000), who argued that due to the large amount of uncertainty regarding future climate change, multiple scenarios that span a range of possible future climates should be adopted. The Intergovernmental Panels SRES emission scenarios are being used to represent a range of potential future climate conditions (Nakicenovic et al. 2000).

Soil Parameters

The soil-water component of the model are being parameterised from plot data from the Biogeoclimatic Ecosystem Classification Database (BECdb) provided by the Ministry of Forests and Range. Plot data that contains rooting zone depth, soil texture and coarse fragment percentage classes for the SBS subzones within the study region are being analysed to calculate the average available soil water holding capacity and field capacity for each site series (SS) within each subzone. Table 1 summarises the number of plots that are being used for parameterising the soil parameters in each subzone.

Table 1: Climate and Soil Data collected and being used for project modelling

Subzone	# of Climate Stations	Minimum Elevation	Maximum Elevation	# of Soil Plots
SBSdh1	3	746	771	95
SBSdh2	2	1059	1067	1
SBSdk	11	522	884	144
SBSdw1	5	671	795	126
SBSdw2	1	899	899	139
SBSdw3	3	579	686	69
SBSmc1	----	----	----	53
SBSmc2	2	716	722	271
SBSmc3	----	----	----	65
SBSmh	3	541	570	51
SBSmk1	4	690	969	96
SBSmk2	1	732	732	59
SBSmm	----	----	----	38
SBSmw	----	----	----	159
SBSvk	3	610	648	168
SBSwk1	3	586	945	354
SBSwk2	1	680	680	65
SBSwk3	1	854	854	67
Total	**43**	**522**	**1067**	**2020**

Preliminary Modelling Results

Preliminary modelling has been conducted in the first year of this project for portions of the SBSdk, SBSmc2, and SBSwk2. Modelling was conducted using climate data from the Smithers Airport, Topley Landing, and Pine Pass Mount Lemoray climate stations. The modelling was conducted to represent four edaphic moisture conditions: subxeric, submesic/mesic, subhygric and hygric. The preliminary results are summarised in graphic form in Figures 1 to 12. The preliminary results illustrate differential responses by species between both edaphic sites and SBS subzones. In each subzone, climatic conditions become increasingly favourable for Interior Douglas Fir and Interior Cedar Hemlock zone species with subxeric sites having the most negative impacts on the SBS species in the SBSdk and SBSmc2 while species responses are mediated by hygric sites. In the SBSwk2 (Figs 9-12), the climate and edaphic conditions remain favourable for the current SBS in the 2080s with large increases in climatic and edaphic suitability for Douglas-fir and western hemlock.

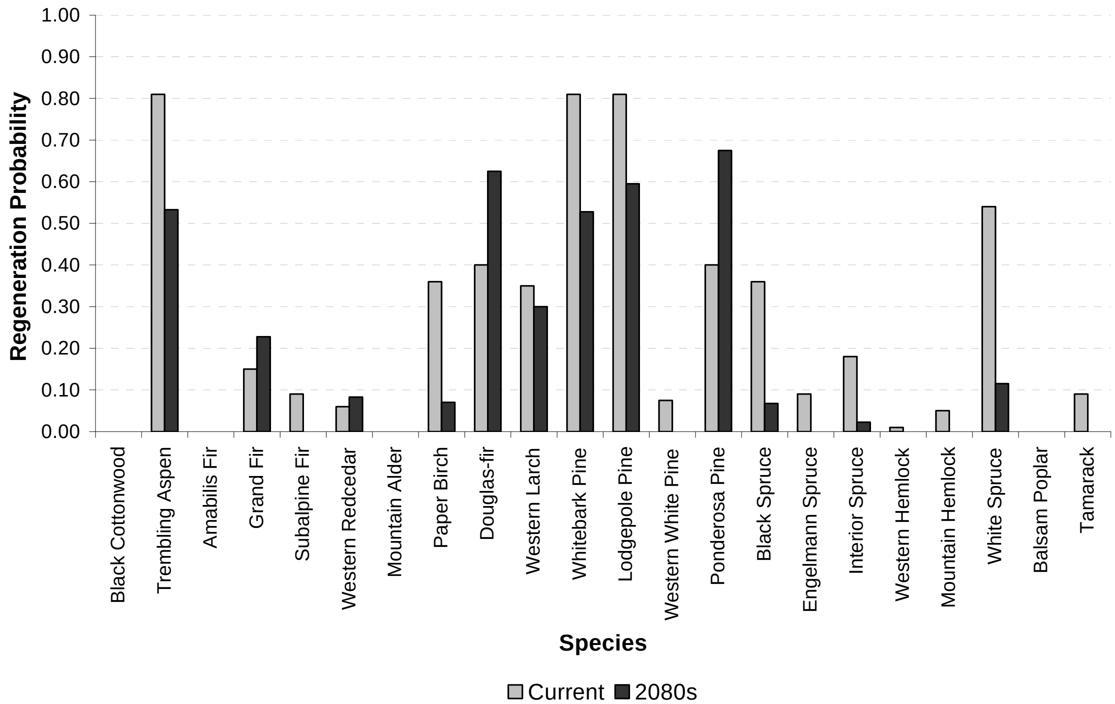

Fig 1: Species response on subxeric site series within the northwestern portion of the SBSdk

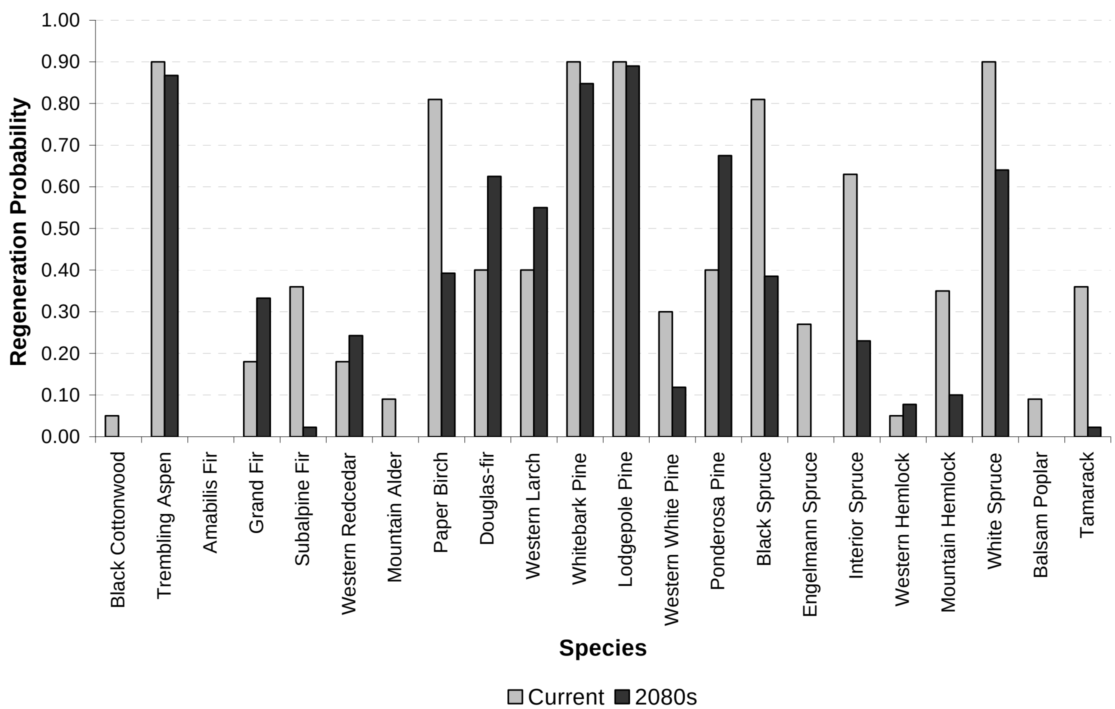

Fig 2: Species response on submesic to mesic site series within the northwestern portion of the SBSdk

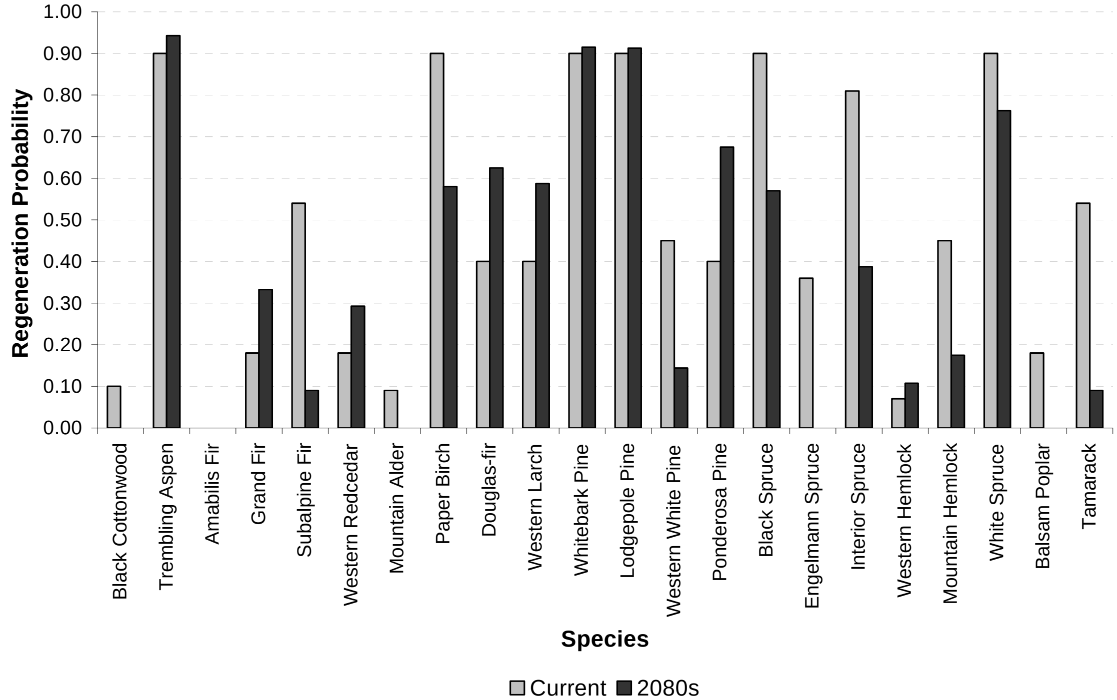

Fig 3: Species response on subhygric site series within the northwestern portion of the SBSdk

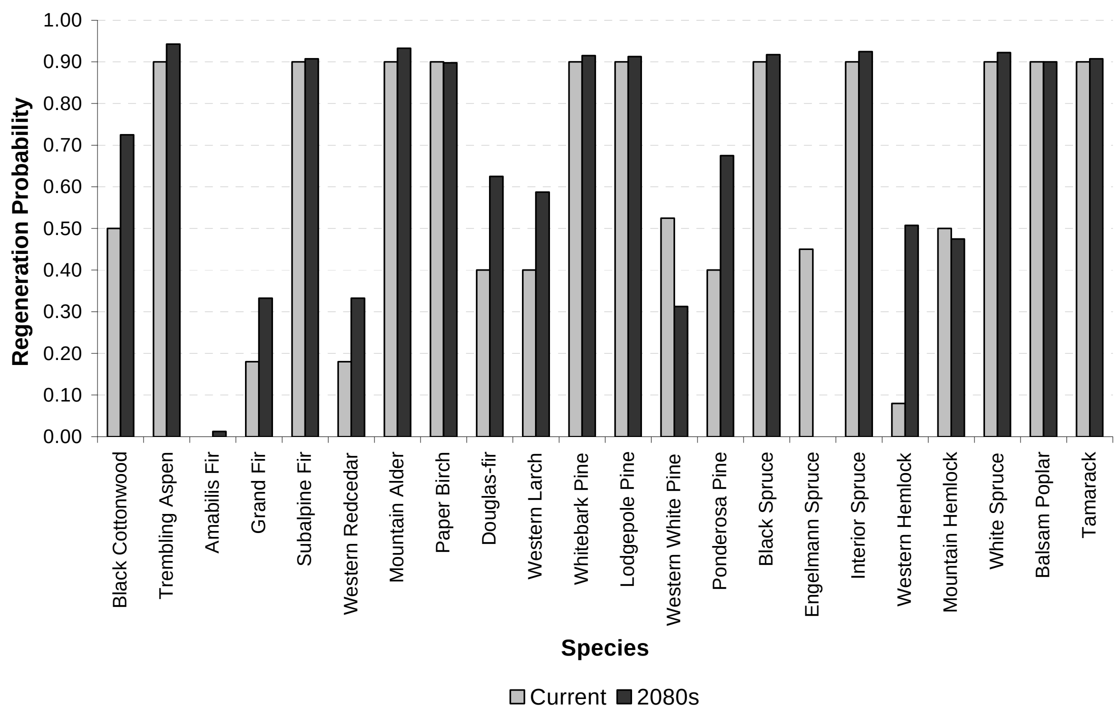

Fig 4: Species response on hygric site series within the northwestern portion of the SBSdk

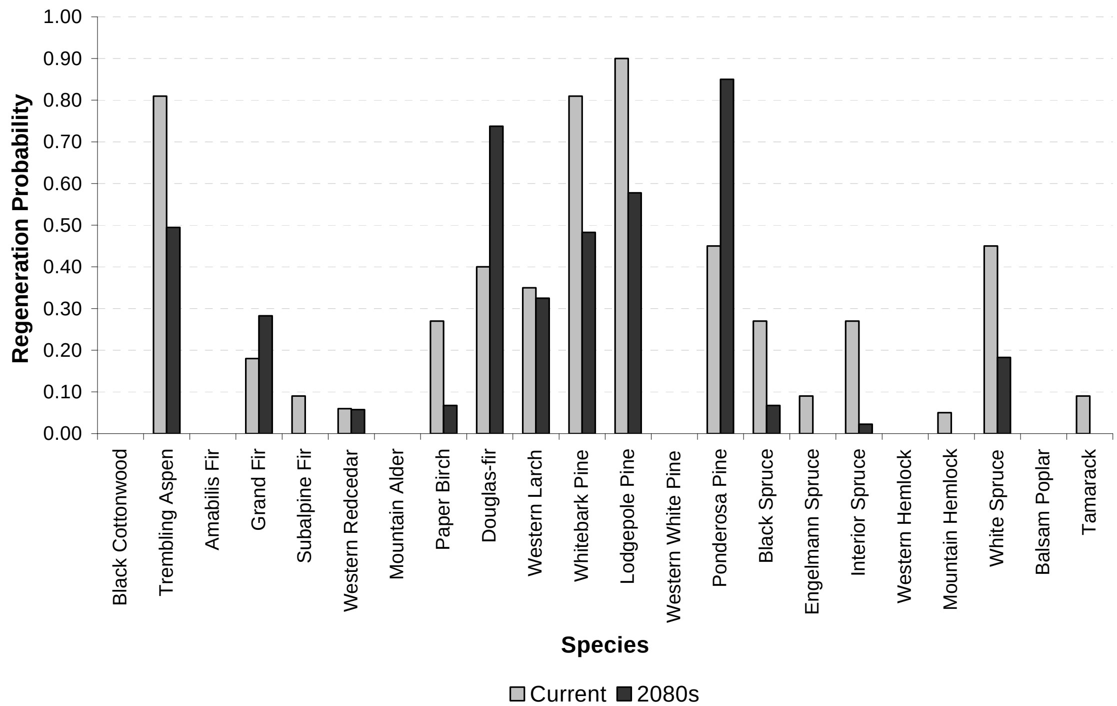

Fig 5: Species response on subxeric site series within the central portion of the SBSmc2

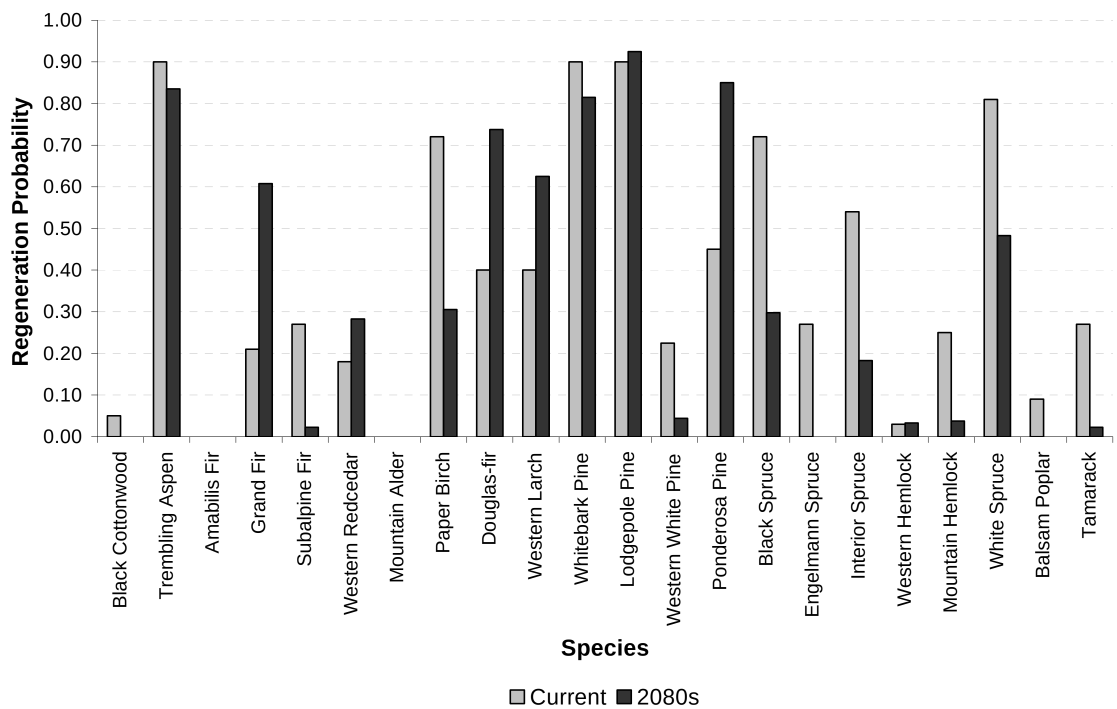

Fig 6: Species response on submesic to mesic site series within the central portion of the SBSmc2

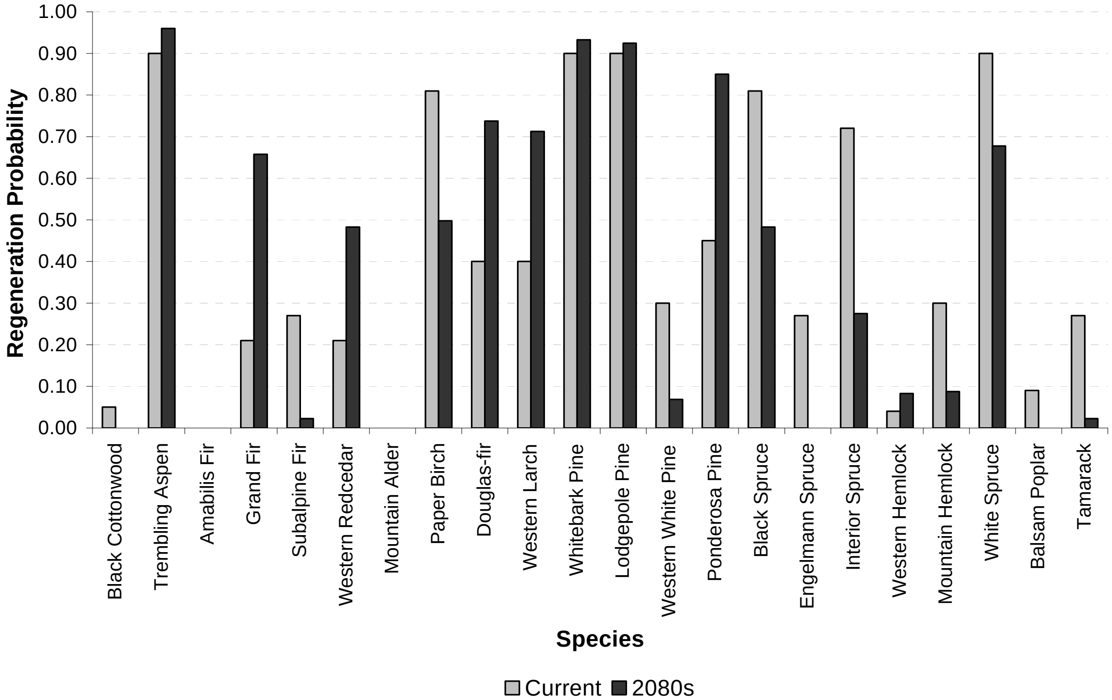

Fig 7: Species response on subhygric site series within the central portion of the SBSmc2

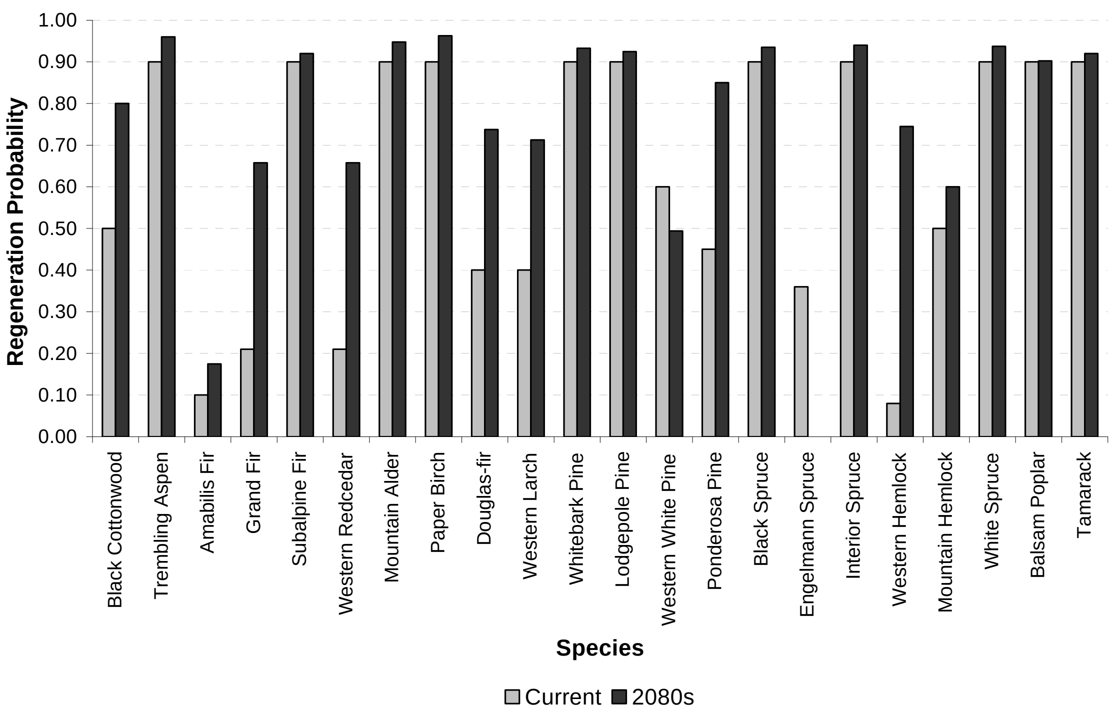

Fig 8: Species response on hygric site series within the central portion of the SBSmc2

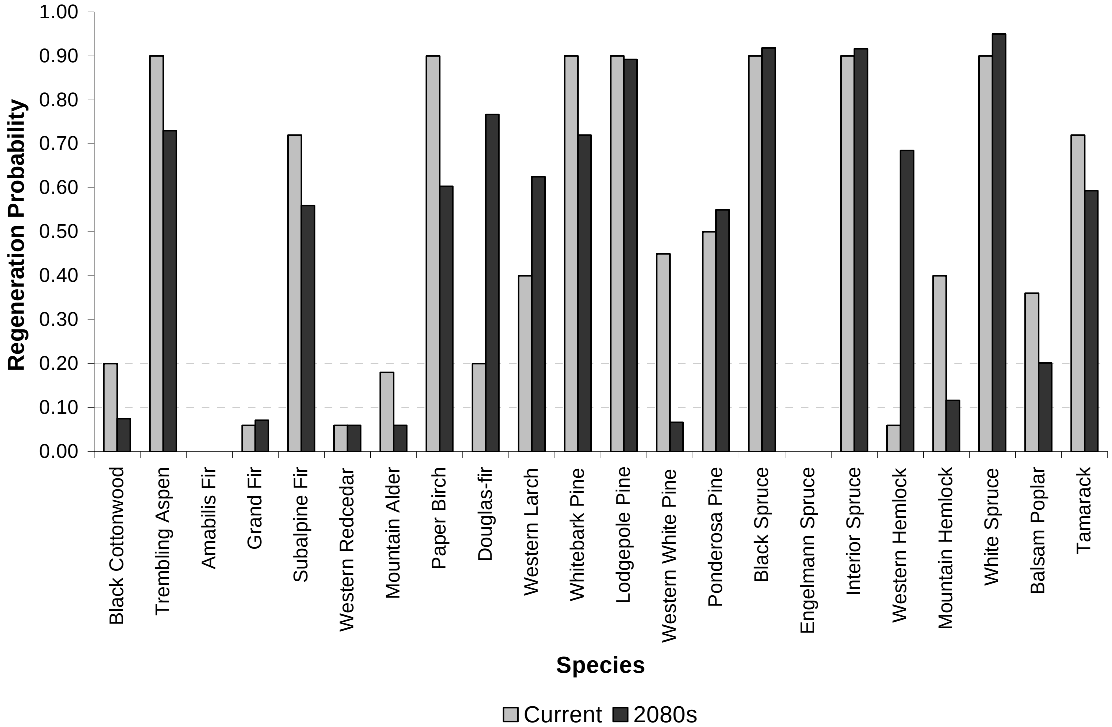

Fig 9: Species response on subxeric site series within the eastern portion of the SBSwk2

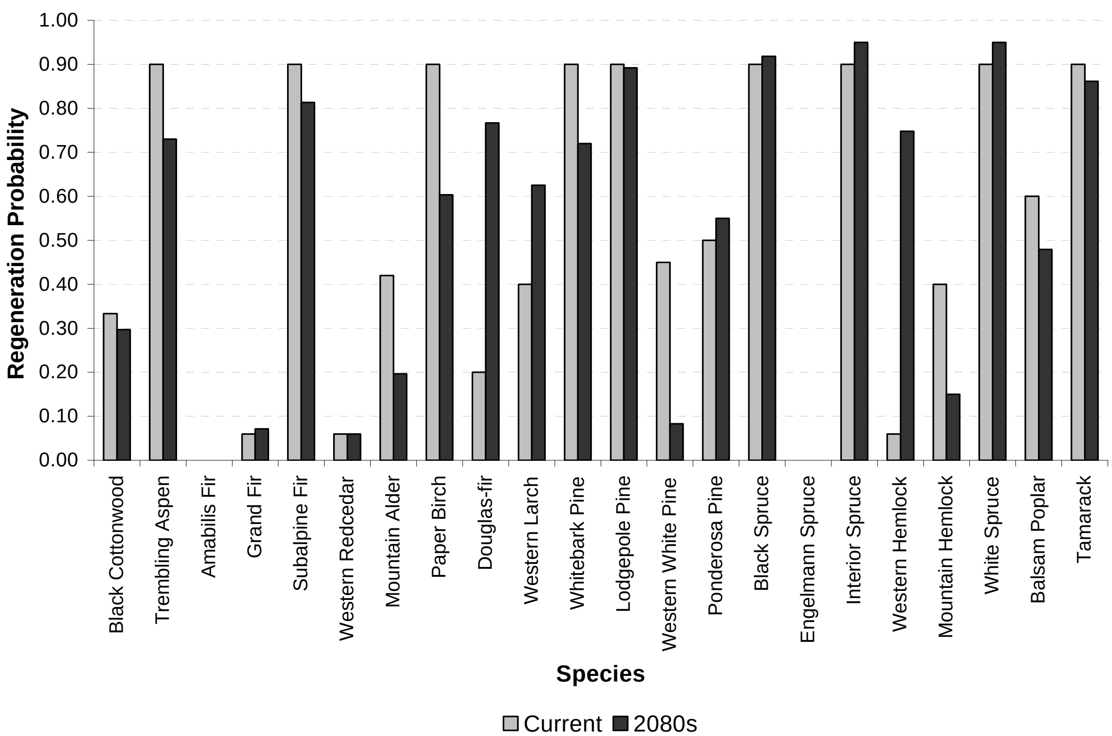

Fig 10: Species response on submesic to mesic site series within the eastern portion of the SBSwk2

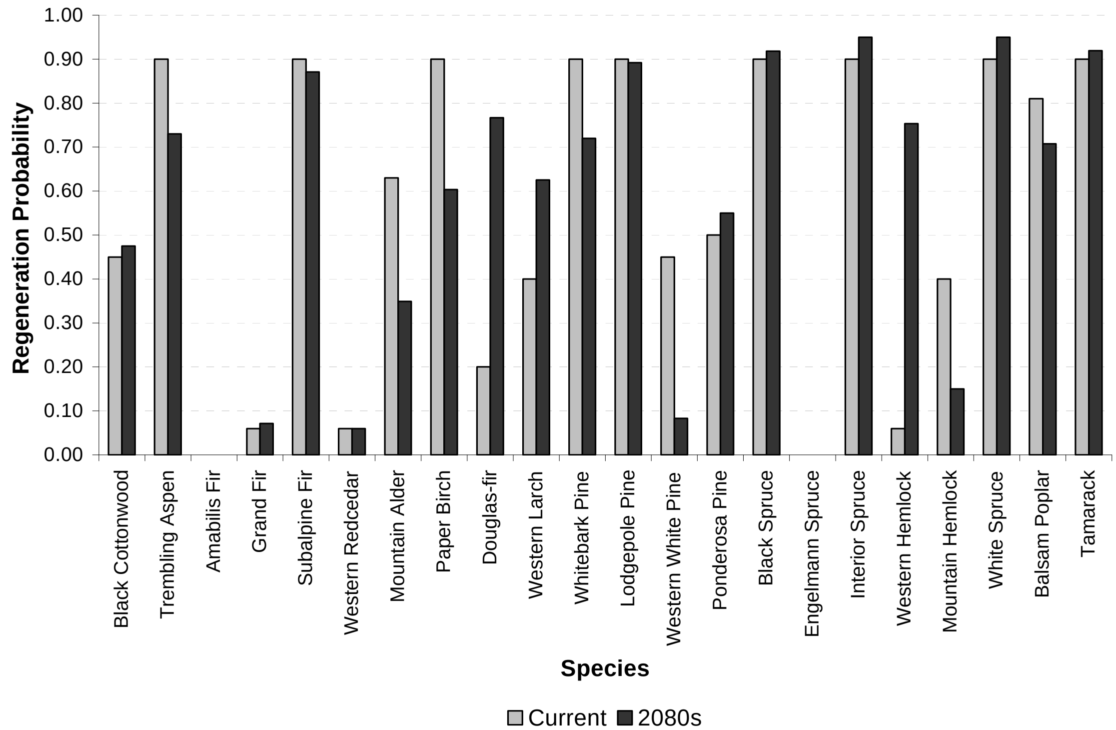

Fig 11: Species response on subhygric site series within the eastern portion of the SBSwk2

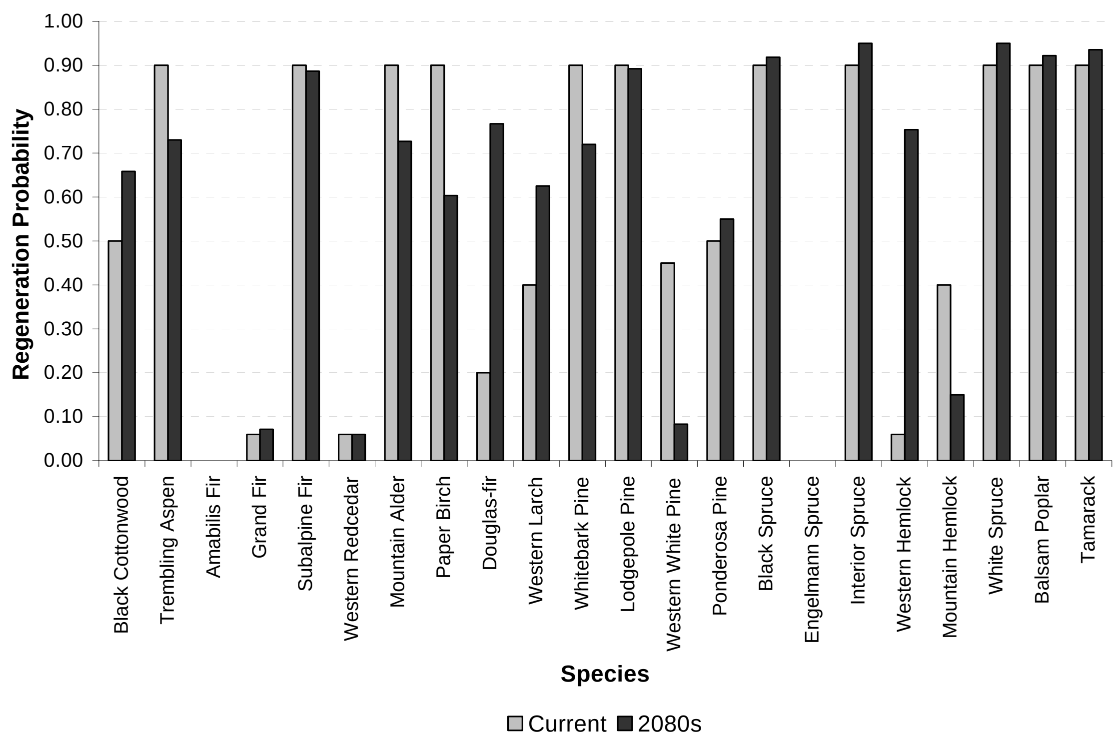

Fig 12: Species response on hygric site series within the eastern portion of the SBSwk2

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