Public Policy Linkages for the Tree Species Adaptation Risk Management Project in Alberta

Deogratias Rweyongeza[1], Barb R. Thomas[2], Shane Sadoway[3] and Dawn Griffin[4]

[1]Forest Management Branch, Alberta Agriculture and Forestry
[2]Department of Renewable Resources, University of Alberta
[3]Blue Ridge Lumber, West Fraser Mills Ltd
[4]Canadian Forest Products Ltd

March 2015

Tree Species Adaptation Risk Management Project,
Funded by Climate Change and Emission Management Corporation (CCEMC) &
Alberta Environment and Sustainable Resource Development

Contents

1.0 Background

Alberta regulates the collection, development, certification, and use of all seed and vegetative material (propagules) used in reforestation and reclamation on public land. This ensures that 1) propagules retain their genetic identity, and 2) propagules are deployed only in places where the climate of the planting site is similar to climate of the propagules' source. The goal is to allow artificially planted forests to retain capacity to withstand unexpected weather changes (extremes) in the short term and genetically and physiologically adjust to a changing climate in the long term.

Prior to the Tree Species Adaptation Risk Management (TSARM) project, the Government of Alberta (GOA) understood that climate change would negatively impact reforestation, forest management, and the sustainability of the forestry industry in Alberta, which are an integral part of the government core business. As part of the GOA climate change adaptation initiatives in forestry, the government did the following:

- Funded and developed the Alberta Climate Model to provide climate and weather data needed to guide the matching of propagules to the planting site. This work was integrated into subsequent Alberta and British Columbia climate model developments (see Mbogga et al. 2010).
- Analyzed the relationship between the population genetics of the main Alberta coniferous tree species (spruces, pines, and larch) and climate, and how their productivity would be impacted by the projected changes in climate (e.g., Rweyongeza et al. 2007a, 2007b, 2010; Rweyongeza 2011). Results from this work were then integrated into a provincial approval system that guides transfer of wild seed across seed zone boundaries within the existing Alberta Forest Genetic Resource Management and Conservation Standards (FGRMS).

Forest companies and the University of Alberta analyzed the relationship between the population genetics of aspen poplar and the climate in Alberta and how aspen productivity would be impacted by a changing climate (e.g., Gray et al. 2011; Schreiber 2013). While aspen is currently managed mainly through natural regeneration, these results would aid transfer of aspen vegetative propagules and seed across seed zone boundaries where the species is or is to be artificially planted.

In addition to generating this immediately applicable knowledge, the early GOA climate change adaptation work in forestry identified four major limitations:

1. Under the projected changes in climate, Alberta would become warmer and drier, with drought increasingly becoming a major constraint to forest regeneration and productivity. The existing GOA and industry conifer and aspen research field experiments do not provide data for satisfactory analysis and identification of drought-tolerant trees needed for reforestation in a drier climate. This is because existing experiments were rarely located in drier parts of Alberta. *The GOA needed to bridge this knowledge gap*.

2. Reforestation in Alberta is increasingly using seed and vegetative propagules developed by region-based tree programs, which use FGRMS that are different from those governing the collection and use of wild seed. *The GOA needed a mechanism for deciding if and how propagules would be transferred across boundaries of breeding regions* (also called controlled parentage programs [CPPs]) as an adaptation to climate change.
3. Although aspen clones could be selected and artificially planted in new environments as part of climate change adaptation, the species is difficult and expensive to propagate clonally (rooting) in the nursery. This makes commercial planting of desirable clones impossible even where climate change adaptation warrants that the species be artificially regenerated. *Hence, the GOA and industry needed an aspen nursery propagation technique that makes commercial planting of the species using vegetative propagules feasible*.
4. Subject to (2.), the GOA, through the Forest Management Branch (FMB), and forest companies operate a series of tree programs that are managed independently, with loose overlaps at a research level. *As part of climate change adaptation, the GOA and forest companies needed to inventory these programs, assess their vulnerability to climate change through a standardized assessment tool, reorganize them (where needed), and synthesize their data to bring synergies among independent operators across the province.*

To address the knowledge gaps and challenges outlined above, and the resulting gaps in provincial climate change adaptation policy, CCEMC launched the TSARM project, with a complementary funding from FMB and in-kind support from both FMB and forest companies. The results are briefly discussed below.

1.1 Development of Expanded Provenance Trial Sites

The work done: The TSARM project completed development of three large experimental sites (≥ 15 hectares each) and completed the land survey and reservation of a fourth site (8 hectares). These sites will provide sufficient experimental space for conifer provenance trials in climates where field experimentation has not been conducted before. In addition, the project completed surveys and land reservations for four sites earmarked for field experimental space for deciduous species, mainly aspen and balsam poplars. These sites are located in places where deciduous species have not been tested before.

Linkage to policy: Developing large field experimental sites carries a high one-time cost, which limits the ability of the GOA and industry to generate research data that support the development of seed-transfer guidelines and climate change adaptation policy. Therefore, even though the actual planting of experimental trees will follow later under separate funding, the TSARM project has advanced the ability of the GOA and industry to address climate change adaptation by creating a research environment that supports policy development.

1.2 Climate Change Vulnerability and Risk Assessment of Tree Improvement Programs

The work done: The TSARM project inventoried parental composition, field experiments, seed orchards, seed production, genetic diversity, distribution of the CPP deployment land base into elevation and latitudinal bands (expected to represent climatic variation within the CPP region), alignment between the climate of the parent trees and that of the approved deployment region, and continuous assessment and measurement of field experiments for all 24 CPP regions. The rationale for this work was to gauge the strength and weakness of these programs given that the flexibility to reorganize or redesign a program to meet changing reforestation needs is part of a program's resilience.

Linkage to policy: Under the FGRMS, Alberta has established a minimum allowable level of genetic diversity before propagules from CPP programs can be used on public land, and the climatic sampling of both parent trees and experimental environments. The information and reports generated by the TSARM project will enable the CPP owners to address weaknesses in their programs in line with the existing provincial standards. The FMB is currently working on a directive to require mandatory use of orchard seed whenever available before considering use of wild seed. Part of the rationale for this directive is to maintain forest productivity and wood supply on a shrinking productive commercial forestry land base that is being impacted by climate change. Therefore, strengthening the adaptability (flexibility) of breeding programs to meet the changing reforestation challenges and needs will aid GOA climate change adaptation policy initiatives.

1.3 Climate Modelling and Analysis of Biological Data

Prior to TSARM, work by the GOA and the University of Alberta on climate change adaptation of conifers and aspen, respectively, focused on transfer of wild seed and clones across seed zone boundaries. In contrast, the TSARM project work focused on transfer of seed and clonal material from tree breeding programs across breeding region (CPP region) boundaries.

The work done: Field height growth measurement data from all nine white spruce and six lodgepole pine breeding regions were compiled and analyzed to examine the potential of seed transfer across regions in light of the projected changes in Alberta's climate. Although some adjustments could be made to allow seed transfer across CPP regions, results show that, at this time, local seed is still the best choice for reforestation in all conifer CPP regions.

Linkage to policy: From the GOA perspective, local seed being the most suitable for reforestation within the CPP region implies that no drastic change in the standards governing collection and use of seed from tree breeding programs is warranted in the short to medium terms. However, because populations (provenances) and parent trees (clones) grow differently across CPP boundaries when examined individually instead of based on the average growth of the entire CPP seed crop, results from the TSARM project will enable the GOA to allow greater and targeted sharing of tree breeding material (parent trees) across CPP regions. This allows climate change adaptation measures to be implemented in targeted sections of the CPP regions without altering CPP region boundaries. It also provides information for identifying and removing individual parent trees that are climatically unsuitable for the CPP region from seed orchards.

1.4 Development of Efficient Propagation Methods for Aspen

In a natural forest, aspen regenerate naturally through a network of roots that began as a single tree from a seed that germinated at a particular point in time. Some of the present wild aspen clones that form much of the Alberta aspen forests arose from seed that may have germinated thousands of years ago. Aspen is a difficult species to propagate artificially in the nursery. Consequently, even if clones suitable for the future climate were identified, the high cost of producing a plantable aspen propagule would hinder climate change adaptation.

The work done: Working with Woodmere Nursery, Smoky Lake Forest Nursery, and Bonnyville Forest Nursery, the TSARM project attempted different vegetative propagation methods to try to reduce the cost per plantable propagule to $0.50–$0.60. This work achieved a cost per plantable propagule of $1.01–$1.52, which is still relatively high. However, given that rooting ability varied among clones, it is expected that identifying easier-to-root clones, combined with economies of scale associated with operational reforestation as opposed to small-scale production in a research setting, should be able to lower the cost per plant to $0.70–$0.80.

Linkage to policy: From a policy perspective, climate change adaptation options have to be fiscally feasible; otherwise, they will never be operationally implemented. Thus, a significant reduction in the propagation cost is an initial step toward implementing provincial aspen clonal deployment standards that have recently been developed in the revised FGRMS (fall 2015).

1.5 Stakeholder Engagement and Climate Change Adaptation

Climate change adaptation begins with the realization and acceptance that the climate is changing, that changes will affect the forestry business, and that there are measures that can be integrated into existing operations to lower negative impacts. Therefore, stakeholder education is part of the provincial climate change adaptation strategy.

The work done: In three years, the TSARM project conducted three stakeholder workshops, one each year, and two visits to field experiments in southwestern and northwestern Alberta. Project participants and representatives from relevant government departments, the University of Alberta and other academic institutions, and the Canadian Forest Service attended these learning sessions. Invited speakers from the climate change adaptation groups in British Columbia, the University of Regina, the Canadian Forest Service, and the University of Alberta presented their work at the workshops. Participants reviewed the TSARM project progress and its potential impact to their operations. Other subjects that were not part of the original project planning but that are becoming increasingly important, such as potential climate change adaptation for forest insects and diseases, were integrated into the workshop and field visits by inviting relevant speakers.

Linkage to policy: Stakeholder engagement has been one of the most successful parts of the TSARM project. Before the beginning of the project, there was very limited understanding and acceptance of why the GOA restricts collection and use of seed and vegetative materials on public land within a system of seed zones and region-based breeding programs. Workshops presenting data from Alberta and British Columbia forest genetics research programs, and visits to field experiments to physically see differences in growth among trees from different seed sources, have helped significantly in changing that. Climate change adaptation is now becoming an integral part of tree breeding field trials being planned by forest companies and a consideration in province-wide reforestation activities.

1.6 Institutional Strength

In addition to addressing the specific climate change adaptation objectives identified in the project implementation plan, the TSARM project has helped to establish a close working relationship between GOA departments and agencies such as Alberta Innovates Bio Solutions, forest companies, academic and research institutions both within and outside Alberta, and the Foothills Research Institute. This alliance, forged through Tree Improvement Alberta (TIA) and stakeholder workshops and field tours, will be a great asset in the future when addressing technical and policy issues related to climate change, tree breeding, forest insects and diseases, and forest research as a whole.

2.0 Acknowledgements

TIA acknowledges access to data provided by the Government of Alberta (Agriculture and Forestry, formerly Environment and Sustainable Resource Development), Alberta-Pacific Forest Industries Inc., ANC Timber Ltd., Canadian Forest Products Ltd., Daishowa-Marubeni International Ltd., Manning Diversified Forest Products Ltd., Millar Western Forest Products Ltd., Norbord Inc. (formerly Ainsworth Lumber), Northland Forest Products Ltd., Tolko Industries Ltd., West Fraser Mills Ltd. (Hinton Wood Products, Sundre Forest Products Inc., and Blue Ridge Lumber Inc.), Weyerhaeuser Company Ltd. (Grande Prairie and Pembina Timberlands).

TIA would also like to acknowledge the collaborative efforts of the TIA board of directors (BOD), past and present, as well as the many others who have contributed to the success of this project. We appreciate the significant contributions of Leonard Barnhardt (retired), Richard Briand (former TIA BOD, West Fraser), and the late Bruce Macmillan, who were among the project applicants, as well as members of the TIA BOD and the TSARM project steering committee, who worked tirelessly to advance the course of the project. Our current BOD and steering committee include Barb Thomas (University of Alberta, TIA BOD), Dawn Griffin (Canfor, TIA BOD), Deogratias Rweyongeza (AAF, TIA BOD), Harry Archibald (project advisor, CCEMC), Kim Rymer (Al-Pac, TIA BOD), and Shane Sadoway (BRL, TIA BOD chair). We thank Ken Greenway (AAF), Nicole Asselin (MNP), and Todd Nash (MNP) for setting up the project implementation framework through TIA, which was crucial for the successful implementation of the project with multiple players.

Thank you to Andreas Hamann (University of Alberta), Jean Brouard (Western Boreal Aspen Corporation), Laura Gray (University of Alberta), and Sally John (Huallen Seed Orchard Company) for their contributions throughout the project and to this final report. Coordination and project management were provided by TIA and the Foothills Research Institute. We further acknowledge technical assistance and data management by staff at the Alberta Tree Improvement and Seed Centre, and Daniel Chicoine (Incremental Forest Technologies Ltd.) for his commitment and steady hand while undertaking all administrative duties in this project and as the manager of TIA.

Funding was provided by the Climate Change and Emission Management Corporation (CCEMC) and Alberta Environment and Sustainable Resource Development as part of Alberta's climate change adaptation initiatives.

We are also grateful for the financial assistance from Alberta Innovates Bio Solutions, Cornelia Kreplin in particular, to assist us in workshops leading to the formation of TIA.

3.0 References

Gray, L. K., Gylander, T., Mbogga, M. S., Chen, P-Y. and Hamann, A. 2011. Assisted migration to address climate change: Recommendations for aspen reforestation in western Canada. Ecol Appl. 21: 1591-1603.

Mbogga, M., Wang, T, Hansen, C. and Hamann, A. 2010. A comprehensive set of interpolated climate data for Alberta. Publication Number Ref. T/235. ISBN No. 978-0-7785-9184-9 (online edition).

Rweyongeza, D. M. 2011. Pattern of genotype-environment interaction in Picea glauca (Moench) Voss in Alberta, Canada. Ann For Sci. 68: 245-253.

Rweyongeza, D. M., Barnhardt, L. K., Dhir, N. K. and Hansen, C. 2010. Population differentiation and climatic adaptation for growth potential of white spruce (*Picea glauca*) in Alberta, Canada. Silvae Genet. 59: 158-169.

Rweyongeza, D. M., Yang, R-C., Dhir, N. K. Barnhardt, L. K. and Hansen, C. 2007a. Genetic variation and climatic impacts on survival and growth of white spruce in Alberta. Silvae Genet. 56: 117-127.

Rweyongeza, D. M., Dhir, N. K., Barnhardt, L. K., Hansen, C. and Yang, R-C. 2007b. Population differentiation of lodgepole pine (*Pinus contorta*) and jack pine (*Pinus banksiana*) complex in Alberta: Growth, survival and responses to climate. Can J Bot. 85: 545-556.

Schreiber, S. G., Ding, C., Hamann, A., Hacke, U. G., Thomas, B. R. and Brouard, J. S. 2013. Frost hardiness vs. growth performance in trembling aspen: An experimental test of assisted migration. J Appl Ecol. 50: 939-949.