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Canadian Forest Service – Great Lakes Forestry Centre

How assisted migration could be used to help forests adapt to climate change

INTRODUCTION

Assisted migration refers to the human-assisted movement of organisms to locations where future climatic conditions would be more favourable. It has been proposed as a strategy for reducing the negative impacts of climate change on Canada's forests. Climatic ranges for many tree species in Canada are expected to shift northward by about 300 km over the next 50 years. Since tree species have an average migration rate of about 0.5 km per year (25 km over 50 years), their ability to keep pace with such a rapidly changing climate is questionable. There is concern that tree species will become maladapted over time, which would lead to a reduction in forest health and productivity, and which could eventually affect biodiversity.

In 2011, the National Round Table on the Environment and the Economy released a report that estimated a reduction in Canada's gross domestic product of $17 billion by 2050 as a result of the impacts of climate change on timber supply. In addition to economic implications, there are ecological concerns. The expected changes in site conditions resulting from differences in temperature and precipitation could cause some species to become stressed, leaving them more vulnerable to pests and diseases. If changed conditions persist over a long period of time, those species might not be able to recover and could eventually become extirpated (locally extinct) or extinct. Assisted migration could allow these species to successfully establish in other areas with more favourable climate conditions. However, assisted migration carries its own set of risks and many questions need to be addressed before implementing such a strategy. In recent years, the pros and cons of assisted migration have been explored and discussed in the scientific community and beyond.

Figure 1. Hardwood plantation 3 years after establishment in Claremont, Ontario. Species include black walnut, black oak, white oak, red oak, shagbark hickory, and sugar maple and include seed sources from Kentucky, Tennessee, Pennsylvania and the local seed zone.

Potential issues associated with assisted migration

Species with declining populations and narrow geographic ranges have been identified as particularly vulnerable to climate change. Proponents suggest that assisted migration may be the only means to save such species. However, there is concern that assisted migration efforts could cause more harm than good, based on historical ecological calamities that have resulted from moving species to locations outside the limits of their native ranges. Some of the potential risks include: invasive spread of the translocated species in the new ecosystem, introduction of novel pests and diseases, failure of the translocation, and over-collection of seeds or cuttings from source populations. These risks have led to debate around whether or not there is an appropriate role for assisted migration in biodiversity conservation efforts.

For Canadian commercial tree species, which generally have large geographic ranges, assisted migration would typically involve the movement of seeds or seedlings within, or slightly beyond, current geographic range limits to avoid maladaptation, maintain healthy forests and realize gains in tree growth and productivity. There is generally less perceived risk around the practice of assisted migration in this context because it would not involve the translocation of species to locations far outside current range limits.

Current situation in Canada

Historically, tree populations were considered to be adapted to local climatic conditions. Most provinces restricted the movement of tree seed and stock outside of established seed zones because of the risk of damage and mortality from cold, drought, insects and disease. However, many resource management agencies are discussing assisted migration and are considering changes to seed transfer guidelines based on the results of seed source trials. If well designed, seed source trial data can provide a nearly complete profile of climatic

preferences for populations distributed across the geographic range of a species, thus allowing optimal planting stock to be identified for any given planting site under current and/or future climate conditions.

Some Canadian provinces have already altered their planting guidelines for commercial tree species because of changes in climate by, for example, allowing the movement of seed sources to higher elevations (up to 200m higher) or more northern latitudes (up to two degrees of latitude). In Ontario, where the movement of genetic material is guided by the Forest Health and Silviculture Seed Directive, the movement of tree seed and stock is currently restricted to within established seed zones. However, these policies are revisited regularly as more information becomes available from ongoing research.

GREAT LAKES FORESTRY CENTRE (GLFC) ROLE

Researchers at the Great Lakes Forestry Centre are working to evaluate the environmental, economic, ethical and practical aspects of assisted migration. Although humans have long moved species outside their natural ranges for agricultural and horticultural purposes, this approach has never been used as a way to adapt to a changing climate. Addressing the many knowledge gaps and uncertainties will lead to informed decisions and policies that will reduce the risks associated with the implementation of this new potential solution.

Members of the Landscape Analysis and Applications Section and of the Ecosystem Research Impact Team at GLFC are involved in a number of projects related to assisted migration. For nearly two decades, a major focus of the section has been the generation of climate maps for a wide range of climate variables and time periods. This effort has produced climate maps for North America dating back as far as 1900 and, based on output from a number of general circulation models, dating forward to the end of the current century.

Another major endeavour of the section has involved the generation of a North American plant distribution database, compiled using data from multiple agencies and the public. This wealth of data has allowed the climate envelopes of more than 3000 plant species to be elucidated and mapped (see http://planthardiness.gc.ca). An understanding of plant climatic requirements and maps of future climate are fundamental support materials for assisted migration efforts.

Experiments exploring the potential for hardwoods from southern seed sources to grow north of their current range and for conifers from northern seed sources to grow south of their current range have also been established near Pickering, Ontario. The hardwood plantation consists of a mixture of red oak, white oak, bur oak, black walnut, shagbark hickory, and sugar maple, while the conifer plantation includes jack pine, black spruce, and white spruce. This work will contribute to an improved understanding of the potential response of trees form the north to climate change and the extent to which trees from the south can be moved northward. Early measurements of the plantations indicate relatively high rates of survival, even for the most geographically distant seed sources (Figure 1).

Another GLFC contribution to this topic is the Seedwhere computer program, which is designed to help match planting stock to both current and future climate conditions. The program works by calculating a climatic similarity index between the target planting location and the seed source. Seedwhere has been used extensively for matching seed sources and planting sites under current climate conditions in Ontario and is being developed as a web application with expanded capacity to incorporate climate change into seed transfer decisions.

GLFC scientist Isabelle Aubin recently developed the TOPIC network (Traits of Plants In Canada), a national network of plant trait databases. Its aim is to promote research collaboration on large-scale key ecological issues, such as climate change, by facilitating data-sharing on the particular plant traits that are most relevant to ecosystem processes. More than 700 species from Québec and Ontario have been incorporated into the database.

Three GLFC researchers (Dan McKenney, John Pedlar and Isabelle Aubin) are part of a Task Group that summarized the state of knowledge on assisted migration in Canada. The results of this effort were presented in a theme issue of the Forestry Chronicle (December 2011) and are being summarized in a report commissioned by the Canadian Council of Forest Ministers. These publications, as well as the research projects outlined above, illustrate the valuable role that GLFC scientists are playing in helping to advance the dialogue, knowledge and practice around the issue of assisted migration.

CONCLUSION

GLFC scientists do not advocate either for or against assisted migration as a means to adapt to a changing climate. Rather, the goal of their research and that of other NRCan-CFS scientists is to work with resource managers to develop scientific knowledge to aid in the analysis of risks and benefits. A thorough understanding of the implications of assisted migration is integral to making sound decisions with regards to whether or how it should be applied on the Canadian landscape.

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SUGGESTED READING

The Forestry Chronicle, December 2011, 87(6). Special section on: Assisted tree migration and climate change.

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