Managing Forests under Climate Change

The Role of Assisted Migration in Southern Ontario

Climate change is predicted to have significant effects on our forests, and therefore the sustainability of our landscape and our society. The resiliency of our forests is a function of site conditions, the many interactions among plants and animals, the amount of forest on the landscape, and historical and current human settlement pressures. It is also a function of genetic fitness and diversity. Our forests are diverse in species, but within each species there are also unique, locally adapted populations and individuals. So any plan to mitigate and adapt to climate change must consider these complex factors as they apply to a local area.

As the climate changes, some individual trees or even whole local populations of a species may not prove adapted to the new conditions, nor have the capacity or time to become adapted. And they may not be able to migrate to more favourable conditions, given the evidence that the climate is changing faster than natural migration, via wind, water and animals, has occurred in the past. Another barrier to migration is the negative effect that temperature and other weather extremes could have on flowering and seed production.

So our forests' capacity to adapt, thrive and provide the many benefits our society needs, depends on the quality of today's forest conservation, management and restoration efforts, and those of our neighbours. Forests in northern US States may contain options for southern Ontario's future forests – both in terms of southern populations of our native species and species new to us. Likewise our northern neighbours will rely on our forests.

Assisted migration is a strategy worth exploring, but we are in a very early review, testing and communications phase. It is just one of many strategies and objectives we need to consider to help our forests adapt to the changing climate:

1. **Conserve and Restore Forests Strategically**, as part of a robust, natural heritage system
   a. To conserve diversity within species = the many unique local populations and individuals
   b. To maximize habitat for all species
   c. To conserve soil and local water systems
   d. To facilitate natural migration processes
   e. To maintain local climate moderation function

2. **Restore Forests strategically**
   a. Focus on restoring the site conditions to those that will support forests
   b. Focus on connecting forests to support natural migration = "assisting migration"
   c. Use high quality seed from genetically fit sources (see guidelines at www.fgca.net)
   ➔ **d. Move southern sources north = assisted migration, where site conditions allow, possibly in a mix with local sources.**
   e. Develop afforestation competencies to ensure the success of plantings

3. **Bank local material off site (ex-situ)**
   a. Collect and bank source-identified seed of species that can be stored long term
   b. Plant seed of other species outside of their origin = assisted migration, to become seed production areas for future climates

4. **Monitor local forests, and document and monitor assisted migration plantings**
   a. to learn more about species' basic biology and determine their vulnerabilities and strengths
   b. to observe climate change effects on different species, sites and ecosystems
   c. Communicate the results to local landowners and forest managers

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Developing Assisted Migration Guidelines for Southern Ontario

Assisted Migration strategically moves genetic material (seed, seedlings, etc), across the landscape to areas where its current climate is projected to be. But as climate change is an active complex phenomenon, assisted migration is an exercise in trying to hit a moving target while determining what ammunition to use. It is largely a strategic experiment that will require monitoring, adjustments and repetition. There are many aspects to consider:

Firstly, moving plant material often inadvertently introduces new species of plants, insects and fungi that can have severe effects on local species and ecosystems. And the species itself may prove invasive in a new setting. But if done strategically, with appropriate planning, implementation and monitoring, these effects can be mitigated.

Secondly, how far should material be moved? Seed moved from a much milder climate may die, or initially grow poorly. But if it survives, over decades of continuing climate change, it could prove to be better adapted than local sources. Or on any one site, a few sources from across a warmer climate gradient can be planted. These sources could also be intermixed with local material to meet the site's short- and long-term forest cover objectives.

Thirdly, what material should be moved? This is a question of genetic quality and fitness. Moving a few clones, or seed collected from only a few individuals, is not a robust strategy for most species. Moving seed sourced from many healthy individuals in a large stand gives you more genetic diversity – a buffer against future pressures. Some trees will die, but others may thrive. To help address these concerns the FGCA is promoting **Woody Plant Seed Collection Guidelines for a Changing Climate** (www.fgca.net).

Doing nothing also has consequences. If we wait decades to bring seed into our landscape, the southern sources may be too maladapted to their changed climate to produce seed.

Scope of effect is another consideration. Even if all our planting efforts used this strategy it will have a limited effect. Consider that current southern Ontario planting programs affect less than 3,000 hectares per year. To have a greater effect on the landscape, the size and layout of the trials are designed with the potential to become high quality seed production areas to support future local forest restoration efforts.

Lastly these plantings can educate the public and local partners about basic forest gene conservation principles, such as seed source, site adaptation and site restoration, which must be addressed whether or not the climate is changing.

These initial trials are helping us develop guidelines for future efforts:

Hosts:
2010 – Oxford County Red and White Oak Trial, Private Landowner Phil Holst (1 ha)
2011 – Oxford County Bur Oak Trial, Municipality of Oxford County (2.5 ha)
2012 – Lemoine Point Bur Oak Trial, Cataraqui Region Conservation Authority (2.5 ha)
2014 – Alfred Plantagenet Twp Bur and Red Oak Trial. (2 ha)
2016 – St Clair Region Conservation Authority Red Oak and Swamp White Oak trial (1.5 ha)

Management Partners:
Forest Gene Conservation Association (FGCA), Forests Ontario (FO)

Concept: Operationally test southern sources of local native species which are valued for afforestation in the area of the planting site and are adapted to the site's conditions and the local forest community.

Principles:

Test afforestation species that

- Maintain local diversity and are adapted to the local sites (e.g. soil texture/moisture)
- Are replicated in other assisted migration trials

Move species generally north (as per climate projections) within their known range

- Consult Natural Resources Canada re climate projections for particular sites.
- Select at least 2 different southern sources from areas with, for example 1- and 3-degrees latitude differences or 15 and 30 days longer growing seasons.
- Consider new species if they are adapted to the site and vegetation community
- Monitor for insects and diseases, particularly invasive alien species

Space trees strategically

- to allow for potentially lower initial survival of southern sources
- to allow trees to be thinned e.g. 6 36-tree plots/source = 216 trees, thinned at 20 to 108, at 40 yrs. to 54 trees (~5mx 5m).

Tend trees as required

- to respond to a species' protection requirements (e.g. deer browse)
- to respond to a species' growth habits – e.g. pruning of multiple leaders

Focus on at least one species to manage for seed production

- Plan spacing and thinning to promote crown development for seed production
- Once mature, monitor pollen maturity and dispersal and flower receptivity, and determine the potential for cross pollination among sources.
- Plant 1 ha minimum and plan for a minimum of 50 and preferably 100 40-year old trees of each source of each species to ensure a good genetic base to produce high quality seed.

Documentation and monitoring are critical to inform future efforts.

Collaborate with other assisted migration project partners re long term monitoring

Roles and Responsibilities:

Landowner will:

- Manage project implementation including site preparation, planting and tending
- Provide future access to site for monitoring

FGCA will:

- Advise on planting design, seed management and stock sourcing and monitoring
- Facilitate communications among their network of contacts

Natural Resources Canada will:

- Assist with climate change projections, stock source selection and monitoring advice

Forests Ontario will:

- Support sites as part of funding programs' guidelines
- Seek interested landowners with strategic sites for Assisted Migration

Example:

Assisted Migration Trial Climate Analysis and Seed Source Selection

Lemoine Point, Kingston Ontario in Seed Zone 36

Landowner and Partner - Cataraqui Region Conservation Authority

This map* shows how the current climate of the Lemoine Point Trial (star) compares to greater eastern North America. The red areas have a climate most similar to Lemoine Point in terms of growing season length, winter precipitation and winter temperature. The green line shows areas that match Lemoine Point's 222 day long growing season. The blue line is 10 days shorter; the red line 10 days longer and the purple line is 50 days longer. Seed sources considered for the trial include stock adapted to the local area and stock from the distant sources indicated by triangles**. The white circles are locations of other assisted migration trials (Pickering area site east of Toronto is a research trial managed by NRCAN/OMNR)

* - map produced using NRCAN's GIS Tool – SeedWhere