Forest Genetic Resource Management Program 10-Year Strategic Plan- Full[1]

Introduction

The Forest Genetic Resource Management (FGRM) Program is a specific purpose of the Forestry Futures Trust (FFT). The funding of FGRM via the FFT provides support for maintaining Ontario's forest genetic assets, for ensuring that genes are conserved and for developing trees that are adapted for future growing environments[2]. FGRM is a valuable resource for forest management in Ontario and contributes to the Crown Forest Sustainability Act (CFSA) purpose of providing for the sustainability of Ontario's Crown forests. The program supports tree improvement, provides a viable and reliable source of genetically improved seed, conserves existing genetic diversity, and supports adaptation to a changing environment. Ontario's three Regional Genetic Associations (Associations), i.e., Superior Woods Tree Improvement Association (SWTIA), Northeast Seed Management Association (NeSMA), and the Forest Gene Conservation Association (FGCA), are partners with Sustainable Forest Licensees (SFLs} and others in implementing a forest genetics program that benefits Ontario's Crown forests. In addition to providing funding through the FFT, Ontario Ministry of Natural Resources and Forestry (OMNRF) researchers study forest genetics and tree improvement to support Provincial policy and operational programs in collaboration with partners, such as the Associations and universities.

This strategic plan is designed to provide interim[3] direction for the Forestry Futures Trust Committee (FFTC) as the FGRM program administrator and to its applicants. Eligible applicants include SWTIA, NeSMA and FGCA. This strategic plan is being developed to further FFTC's capacity to ensure its instructed allocation of funds for the FGRM Program purpose is done with sufficient oversight and to demonstrate how funding is being used to support important strategic priorities. Applicants are required, in the application process, to demonstrate how project proposals support strategic priorities described in this document. This program direction may be updated from time to time.

Vision and Mission

Vision: An innovative, progressive, and informed program that is recognized as a leader in FGRM by the forestry community.

Mission: To maintain and enhance Ontario's forest genetic resources to meet the sustainable objectives of forest managers and the Province through funding administration.

Guiding Principles

- Provide a high return on investment while supporting the sustainability of Ontario's Crown forests.

[1] Document to be used by the Forestry Futures Trust Committee (FFTC) and the Associations to ensure its instructed allocation of funds is done with sufficient oversight and to demonstrate how funding supports important strategic priorities.
[2] Mandate for the FGRM special purpose is described in the OMNRF Minister's letter — December 2021.
[3] This is an interim document until the Province develops updated strategic policy direction for the FGRM Program

- Support applications that are innovative, responsive, and adaptive while complying with applicable legislation and policy.
- Build collaborative, diversified, transparent and equitable relationships while respecting participants' independence.
- Support applications that incorporate science, technological developments, health and safety, and traditional knowledge into program practices.
- Support applications that prioritize adaptation and mitigation to a changing climate while maintaining the genetic diversity of populations.

Strategic Funding Goals, Objectives and Strategies

The FGRM Program has two strategic goals:

Goal 1—Creating and Maintaining Resilient Forests —FGRM programs that support the resiliency of Ontario forests.

Resilient forests are healthy, productive and are more likely to withstand and adapt to natural disturbances (e.g., pests) and those arising from a changing climate. This will sustain them in the long term.

Genetic diversity is a key element for ensuring populations and communities can adapt to ever changing environmental conditions. Genetic diversity improves a species' ability to cope with environmental stresses such as climate change and new diseases.

Objective 1.1	**Improve forest health and productivity**
Strategies	Strategy 1.1.1- Improve forest growth and quality by producing high-quality seed and/or genetically improved high-quality seed to meet forest management plan (FMP) silviculture objectives. Example projects may include: • *First and second-generation tree improvement programs are managed to improve growth (e.g., early growth for site occupancy without herbicides) while maintaining genetic quality and diversity* • *Investigate advanced techniques to support more rapid tree breeding cycles* o *Collect data to support development of genomics models for priority species* • *Investigate options for incorporating improved stem form and quality by supporting and advocating for associated research*
	Strategy 1.1.2- Investigate opportunities for use of non-traditional species for improvement including hardwoods. Example projects may include: • *Develop prioritized list of species for consideration in improvement programs*
	Strategy1.1.3- Improve resistance to pests (native and invasive). Example projects may include: • *Develop list of prioritized species and pests that offer best opportunity for success (e.g., white pine blister rust, beech bark disease)* • *Support research to improve pest resistance for prioritized species*
	Strategy 1.1.4- Support seed transfer. Example projects may include: • *Maintain or enhance production of high-quality, well-adapted and improved seed*

	Strategy 1.1.5 Maintain and rejuvenate tree improvement (TI) assets (tests and orchards). Example projects may include: • *Maintain or enhance production of high-quality, well-adapted and improved seed* • *Explore how existing assets can support future advanced programs* • *Explore incorporating abandoned installations to fill important TI program gaps (private or Crown)*
	Strategy 1.1.6- Advocate for and support forest genetic research, knowledge and information sharing, and skill set development that helps build capacity. • *Example projects may include:* • *Support university faculty and student initiatives* • *Advocate for and, where possible, participate in collaborative research networks (not restricted by jurisdiction) that use traditional and advanced techniques to support more rapid tree breeding cycles better able to respond to the risks posed by a changing climate and invasive pests* • *Advocate for and collaborate to build capacity*

Objective 1.2	**Conserve genetic quality and diversity**
Strategies	Strategy 1.2.1- Improve understanding of genetic diversity among forest practitioners.
	Strategy 1.2.2- Develop orchard establishment practices and other best management practices (BMPs) to maintain genetic diversity. Example practices may include: • *Practices that consider effective population size to maintain genetic diversity in orchards*.
	Strategy 1.2.3- Support the production of high-quality seed that is diverse (species and provenances). Manage orchards that have improved representation or diversity of species and provenances, as appropriate, while producing seed that is well adapted to a regeneration site.
	Strategy 1.2.4- Gene banking – inform, advocate, and support banking of high-quality and improved material (e.g., seed or clonal). Example projects may include: • *Gene banking by the Associations at Ontario Tree Seed Archive and/or National Tree Seed Centre*
	Strategy 1.2.5- Initiate and maintain gene conservation for declining and/or threatened tree species (e.g., beech, hemlock)
	Strategy 1.2.6- Improve genetic quality in post-harvest forests where natural regeneration is used (e.g., selection, shelterwood or seed tree). Example projects may include: • *Develop best management practices (BMPs) that improve the genetic quality and diversity of naturally regenerated stands* • *Share and communicate BMPs with forest managers to improve genetic quality* • *Support the establishment of operational trials to ensure BMPs are feasible across ecosites and post-harvest conditions (e.g., low market conditions or second rotation forests with high variability in age and competition of second growth balsam fir, etc.)*
	Strategic 1.2.7- Improve understanding of those practices that are included and excluded in definitions of genetic engineering. Example projects may include: • *Develop communication materials that describe what is a genetically modified organism (GMO) and what is not. Relate to FGRM practices in Ontario.* • *Develop communication materials to clarify that traditional tree improvement does not involve genetic engineering.*

Objective 1.3	**Manage for resilience in a changing climate**
Strategies	Strategy 1.3.1- Improve collective knowledge, technical capacity and expertise of climate change adaptation. Example projects may include: • *Increase Associations' collective expertise and capacity to analyze potential climate change impacts* • *Improve Associations' technical capacity to manage assets (orchards, tests) to support resilience in a changing climate* • *Investigate assisted migration (population and species) in both wild and improved material* • *Investigate introduction of non-traditional species such as red spruce — range expansion* • *Facilitate establishment of trials that support adaptation to climatic changes, e.g., assisted migration trials).*
	Strategy 1.3.2- Encourage collaborative research that supports resilience in a changing climate. Example projects may include: • *Advocate for and participate in collaborative research networks that use traditional and advanced techniques to support time-sensitive tree breeding cycles better able to respond to the risks posed by a changing climate and invasive pests* • *Investigate potential for wind resistance as an option for improvement*
	Strategy 1.3.3- Investigate risk mitigation BMPs to improve climatic resiliency in stands where planting isn't the main method of regeneration
	Strategy 1.3.4- Support forest managers to understand the expected impacts of climate change while working to meet FMP objectives. Example projects may include: • *Share knowledge, technical support (including data) and expertise with forest managers*

Goal 2—Recognition of FGRM — Recognition of FGRM's fundamental role in improving Ontario's forest estate.

An approved FMP establishes the long-term direction for a management unit and describes the forest operations that may occur. FGRM offers unique opportunities to sustain and improve the forest estate that are not achieved by other mechanisms. For example, FGRM can assist in responding to a changing climate or to natural disturbance challenges while maintaining genetic diversity and improving the wood supply. Given the critical role that FMPs play in Ontario, the role of FGRM needs to be clearly linked to meeting FMP objectives.

Objective 2.1	**Demonstrate the value of investing in FGRM**
Strategies	Strategy 2.1.1- Set out the value-proposition[4] for an enhanced FGRM program in Ontario. Example of value proposition: *Provides high-quality well-adapted seed, provides recognized genetic gain, supports voluntary forest certification efforts, supports renewal where herbicide use is reduced or*

[4] Value proposition - a clear, compelling description of how FGRM meet the needs of clients in a way that alternative programs (or methods) do not. The benefits provided must be specific and unique. (Adapted from: www.bdc.ca)

	eliminated, supports adaptation in fire-prone or climate-impacted environments and supports gene conservation through maintenance of ex-situ gene conservation assets.
	Strategy 2.1.2- Promote the Associations as critical for managing Ontario's forest genetic assets, e.g., orchards, family tests, progeny test sites, provenance trials. Example projects may include: • *Prepare a five-year summary for circulation to OMNRF, FFTC and SFLs describing the FGRM program's accomplishments versus funds spent over the previous five-year period. (Example of return-on-investment information.)* • *Present the five-year summary to OMNRF, FFTC and SFLs. Use this as an opportunity to more effectively engage both OMNRF and SFLs in management of FGRM. Perhaps a biennial presentation could be introduced to report on progress for the strategic plan's goals and objectives.* • *Establish a system to manage, retrieve and share historical and future data (knowledge mobilization) including a geo-referenced database of assets*
	Strategy 2.1.3- Use the program's strategic plan to raise the profile and advocate for FGRM support (financial, in-kind, personnel, information) from Ontario, forest industry, new partners and the public. Example projects may include: • *Prepare an annual program plan that monitors and reports on progress to deliver strategic goals and objectives.* • *Use the return-on-investment information to advocate for support from new and existing partners.* • *Monitor external 'policy' developments to determine best opportunities for partnerships and funding.* • *Improve public awareness about the strategic importance of this work and the need to manage existing assets, including orchards and test sites.*

Objective 2.2	**Support FMP objective achievement**
Strategies	Strategy 2.2.1- Promote a stronger link between FGRM and FMP objective achievement. Example projects may include: • *Develop BMPs related to, e.g., seed supply and residual tree selection that provide tools for forest managers to consider gene conservation.* • *Advocate for improved clarity of annual reporting documentation that is succinct but supports analysis and audits*
	Strategy 2.2.2- Improve Associations' collective understanding of genetic gain and gene conservation so that they are better equipped to support forest managers' initiatives to meet FMP objectives.
	Strategy 2.2.3- Promote the integration of FGRM into Ontario's growth and yield program. Collaboratively advocate for a standard defensible process for identifying genetic gain through traditional tree improvement or through adaptations to a changing climate. Example projects may include: • *Advocate for development of sample yield curves for stands regenerated using improved seed (e.g., jack pine, black spruce, white spruce, white pine)*
	Strategy 2.2.4- Support FMP objective achievement while addressing climate change. Example projects may include: • *Share knowledge, technical support (including data) and expertise with forest managers* • *Work with SFLs and planning teams to ensure local trials and knowledge can be captured*
	Strategy 2.2.5- Provide high-quality wild seed or high-quality genetically improved seed to meet FMP silviculture objectives. Example projects may include:

	• *Provide analytical support to identify high-quality seed sources that are adapted to the current planting site and future growing conditions* • *Identification of areas for high-quality seed collection to support planting efforts*

This strategic plan guides FGRM program implementation and funding opportunities. It is anticipated that this document will be reviewed every 5 years to ensure effective application and progress.

Each Association will develop project proposals and applications to align with this strategic plan and that reflect the unique geography, abilities, expertise and members of each of the Associations.

Appendix A- Action Plan for the first 12 Months and Beyond

i. Annually each association will develop specific tactical actions that deliver on the strategic plan's goals, objectives and strategies.
ii. These actions will be identified in annual Project Submissions and performance will be assessed and reported in annual Project Work Reports.

Appendix B- Overview of the Current State

Forest genetics and tree improvement have been ongoing in Ontario for about 100 years. Reforestation using selected species and seed started early in the 1900s to restore abandoned farmland. In the 1920s, the federal government began the initial research at Petawawa to study how trees vary across a species range. The provincial government became involved after World War II and until the 1980s it also had a strong research focus. The period from the 1950s to the 1970s included the initiation of tree improvement (1958), the establishment of seed collection zones (1961) to ensure adaptation of planted trees, and tree improvement for commercially important species. In the 1980s, the current approach to tree improvement work for commercially important species began. For example, during this period black and white spruce, jack and white pine seed orchards were established. This work was supported by the Tree Improvement Master Plan for Ontario (1987) that provided strategic and technical direction. The OMNRF and the forestry industry funded this work under cooperative tree improvement councils, e.g., Ontario Tree Improvement Board.

After the passage of the CFSA (1994), the OMNRF transferred forest management responsibilities to SFLs, changing the delivery model for forest management throughout the

Historical context and legacy

Landscape structure and species composition has changed from its pre-settlement condition. In the more settled parts of Ontario and particularly in southern and central Ontario, forests have been impacted by early harvest of the dominant trees for export, agricultural clearing, urban development, human caused fires, wildfire suppression, introduction of invasive pests and plants as well as past forest management practices. This has changed the landscape distribution, stand structure, species composition, and genetic diversity and quality of the remaining forests. (OMNRF, 2010, OMNRF, 2014a and OMNRF 2014b.)

province. The earlier Ontario Tree Improvement Board evolved to become Forest Genetics Ontario (FGO). The FGO coordinated the three Regional Genetic Associations in undertaking tree improvement activities with provincial government funding and in-kind contributions from SFLs. FGO was dissolved in 2015 and the three Regional Genetic Associations continued to support and manage FGRM programs including tree improvement.

Today, the SFLs and the three Regional Genetics Associations manage the remaining provincial forest genetic assets. Tree improvement practices are incorporated in the management of these genetic assets. Managing these assets provides a viable and reliable source of improved seed while conserving genetic diversity and supporting adaptation to a changing environment. The Associations receive directed funding from the FFT in accordance with detailed eligibility and evaluation criteria. The benefits of these assets and their stewardship provide a valuable resource for forest management in Ontario. These activities contribute to the CFSA purpose of providing for the sustainability of Ontario's Crown forests.

Funding

From 2015—17, OMNRF authorized FFT funding up to a maximum of $300,000 per year. Beginning in 2017, the OMNRF increased the maximum FFT expenditure to $675,000 per year, comprised of $375,000 in core funding plus eligibility for $300,000 in project funding. This current funding arrangement is committed to March 31, 2027.

Management of forest genetic assets, genetic conservation and developing trees adapted to future growing environments is conducted in accordance with the requirements of the CFSA, its regulated manuals and in recognition of applicable provincial policies, plans and strategies.

Appendix C- Major Internal and External Challenges to Address

Implementation of the FGRM Program Strategic Plan faces both internal and external challenges. Internal challenges include those that the Associations and/or the FFTC can control, at least in part, versus those that are external and therefore beyond their control.

FGRM offers solutions to the threats posed by external challenges if there is a commitment to invest the resources (financial, staffing and policy) to effectively support the program.

Threats impacting the long-term health and sustainability of Ontario's forests represent both an external challenge and an opportunity that could be met by a well-resourced FGRM program. The external challenges include, a changing climate, disturbance from pests (invasive and native), windstorms and fire, biodiversity impacts, increasing government policy constraints and escalating demands from voluntary certification standards (e.g., seeking to reduce or eliminate herbicides as a management tool).

A clearly articulated description of why the FGRM program should be supported is an internal challenge. A description of the multi-faceted values (historic and forecast) provided by the program should be documented and shared with potential supporters. Questions that need to be answered include:

- Why should government devote resources to address the long-standing gap represented by outdated strategic direction that has existed since the mid-1990s and the passage of the CFSA?

- Why should government and the private sector invest and support the program particularly in the context of an uncertain economic outlook and strained budgets?

  The FGRM program will need to clearly demonstrate its value proposition to maintain and potentially increase investment in its projects but to do so requires an understanding of the current actual costs and benefits. Creating an accurate financial overview is a challenge because an accurate summary of the resource support (funds and in-kind) derived from non-government sources is not well documented. This shortcoming in understanding should be addressed as a near term priority.

  A better and more sustainable financial model would show a realistic forecast of diversified resource support.

Appendix D- Strategic Analysis of the Internal and External Environment

Strengths, Weaknesses, Opportunities and Threats (SWOT) Analysis

A SWOT analysis was used to examine the FGRM Program's strengths, weaknesses, opportunities, and threats to inform the strategic planning process. A SWOT analysis examines internal strengths and weaknesses and examines the external opportunities and threats in the environment FGRM operates in.

Strengths
Associations and their partners have experienced FGRM managers
Strong existing and developing climate and genetic science in Canada supports work by the Associations and their partners
FMP process provides the opportunity to support FMP objective achievement and thus provides for a meaningful practical and implementable connection
Existing tree improvement assets, including but not limited to clonal orchards and genetic tests
Good collaboration among the Associations
Collaborative expertise of staff, members, and partners

Weaknesses
Limited policy and strategic direction specific to FGRM
Recognition of the benefits of gene conservation and tree improvement is inconsistent among the three Associations and the various offices of OMNRF
Gene conservation, genetic gain and other benefits become more difficult/complex in era of climate change and changing impacts
General loss of technical and scientific elements and skills pertaining to FGRM, e.g., grafting, genetic data analysis, etc.
Limited capacity to replace or supplement personnel with the scientific and/or technical skills to manage forest genetic assets, including managing the tree improvement program.
Tracking of improved seed and its use varies across Ontario
Weak recording of support from non-government sources
Minimal OMNRF policy pertaining to tree improvement and genetic gain

Opportunities (with Potential Outcomes)
Improving or expanding partnerships with other organizations—strong collaborative partnerships create additional capacity and accelerate change
Forest genetics offers a potential solution for improving regeneration growth and quality in circumstances where herbicides are reduced or eliminated as a tool
Potential for the Associations to be more connected to SFLs and their data describing the quantity and use of genetically improved seed — assists the Associations in gaining a better understanding of the relative need for genetically improved seed by species and assists them in appropriately managing forest genetics assets to respond to increasing or declining needs.
Create interest at college or university level—increases potential pool of future employees and fosters additional research.
Positive advocacy—improves government, industry and other partner support
Partnerships with others (e.g., expand membership beyond forestry companies)—improves access to additional funding and resources.
Funding support from non-government sources could be improved —improves leverage of existing funding.
Improved and consistent reporting of non-government funding and in-kind support for FGRM — increases recognition of the efforts made by SFLs and others, provides opportunity for improved leveraging of funding.

Threats
Loss of future government or industry support
Without economic benefit, forest managers will put funding elsewhere
Continued funding from FFT could be at risk, given increasing fires, pests, etc.
Unknown if the OMNRF will continue its funding for forest genetics activities after the current funding ends March 31, 2027
Funding for forest genetics program is insufficient to fully achieve goals

PESTLE Analysis

The FGRM Program does not operate in a vacuum with many external factors potentially affecting its success. A **PESTLE** analysis was conducted to do a more in-depth analysis of the macroenvironmental factors and long-term trends that may affect the FGRM program. A PESTLE analysis has six categories (political, economic, sociocultural, technological, legal and environmental) that are used to examine the external environment that may impact a for-profit or not-for-profit entity. It will help the Associations and the FFTC to understand the broader issues outside of FGRM and therefore make better, more informed decisions.

Opportunities for the FGRM Program are ***bolded and italicized***.

Political Factors

The FGRM program is supported by resources from both the Ontario government and the forest industry. Political factors will influence the willingness of governments and industry to support the FGRM program and any future enhancements to it. ***Developing and marketing a value proposition for***

FGRM will assist in securing continued FGRM Program funding and obtaining new funding sources. Strong forest industry support for FGRM may influence the future direction of the program.

The ongoing softwood lumber dispute between Canada and the US affects the profitability of the forest sector and may limit their willingness to fund projects.

The Ontario government's priorities are focused on building/rebuilding the economy, building the infrastructure to support the economy, and health care to ensure that the Ontario economy stays open while keeping Ontarians' costs down.

The federal government made recent commitments that may affect how an FGRM program will be supported in the future. These commitments represent potential new partnership opportunities for the FGRM Program. Negotiations at the United Nations (UN) Biodiversity Conference, Conference of Parties (COP) 15 and the resulting agreement —Kunming-Montreal Global Biodiversity Framework (UNEP. 2022) and the UN conference on climate change at COP 27 (UNFCC. 2022) are of potential interest to the FGRM program. They both may have potential impacts on a future FGRM program. Further details are provided under the Environmental Factors of this analysis.

Economic

Developing and marketing a value proposition for FGRM will assist in securing continued FGRM Program funding and obtaining new funding sources. The immediate economic outlook is uncertain. Private and public sector willingness to spend funds on new projects will be cautious. An economic slowdown is predicted for 2023 and 2024 (PBO. 2023) and may negatively impact governments' willingness to spend dollars during this period. The Canadian and US governments' tighter monetary policies have resulted in higher interest rates which has reduced housing construction and decreased the price and demand for lumber and panel products. It will be more competitive and more challenging to obtain funds. This cautious uncertain economic environment may continue for some time due to the global factors that caused it.

In 2020, the OMNRF released Sustainable Growth: Ontario's Forest Sector Strategy (OFSS) (OMNRF. 2020a). It establishes five key principles, including Ensuring Sustainability and contains four 4 pillars of action, including: "promoting stewardship & sustainability, e.g., applying best research and science and responding to a changing climate" and "putting more wood to work, e.g., increasing forest growth". There is an opportunity for FGRM to market its potential to address specific actions in the OFSS. ***There is an opportunity for the Associations to work collaboratively to identify key areas that they can address to move the OFSS forward.***

Sociocultural

A clear definition of genetically modified organisms (GMOs), describing what they are and what they are not would be a beneficial component of the FGRM Program Strategic Plan. Developing a strategy related to GMOs and/or genetic engineering is also advisable given that the public wishes to be aware of which products are GMOs or are genetically engineered while a proportion of the Canadian population opposes GMOs. Gene-editing, where new genes are not added but are turned on or off or varied, e.g., non-browning apples, has potential application in future FGRM programs.

Two forest certification standards voluntarily used by Ontario's forest managers, the Canadian Standards Association (CSA) CAN/CSA-Z809-16 (R2021) Sustainable Forest Management Standard (CSA

Group. 2016) and the Forest Stewardship Council (FSC) National Forest Standard (FSC. 2018), specifically mention that genetically engineered or genetically modified trees are not to be used. The Sustainable Forestry Initiative (SFI) standard (SFI. 2022) does not refer to GMOs or genetically modified trees but instead specifies the importance of best scientific methods for those using improved planting stock. Certification is voluntary but may influence a licensee's practices while recognizing that they must comply with the legislative and policy framework of the jurisdiction in which they operate.

In 2022, FSC embarked on a genetic engineering learning process to improve its knowledge about genetic engineering on lands that are not currently FSC certified. Monitoring this development and potential impacts on a future FGRM program is advisable.

Two forest certification standards, SFI (SFI. 2022) and FSC (FSC. 2019) require the use of integrated pest management (IPM) in those forests voluntarily certified to their standards. SFI indicates that chemical use should be minimized while the long-term goal of the FSC Pesticides Policy is "to eliminate the use of chemical pesticides in FSC-certified forests". FSC requires certified Organizations to use IPM to avoid or eliminate the use of chemical pesticides in certified management units. It also incorporates a risk-based approach, where chemical pesticides may be used after identifying and considering the most probable impacts of available pest management strategies. Forest genetics provides an opportunity to improve the growth and quality of regeneration allowing it to be successfully established sooner in circumstances where the use of herbicides is reduced or eliminated as a tool.

Technological —open and accessible data

Determining if and how the FGRM program pursues the concept of open data and data sharing given its years of investment and historic and future data collection is important. ***There is an opportunity to digitize and share this data to support current and future research and program development. Accessible data supports innovation, investment and promotes efficiency.*** Both the Canadian and Ontario governments have embraced the concept of open data and are sharing their datasets with the public.

Legal and Relevant Policies

Any future sourcing of seeds or other genetic materials from outside Ontario will need to follow the federal and provincial sanitary and phytosanitary requirements and appropriate policies.

Ontario establishes the legislation and policy that directs the management of forest genetic assets. Regional Genetic Associations in cooperation with forest managers plan and manage these forest genetic assets. Management of forest genetic assets, genetic conservation and developing trees adapted to future growing environments is conducted in accordance with the requirements of the CFSA, its four regulated manuals and in recognition of provincial policies, plans and strategies.

The FFT is authorized under the CFSA to provide a funding source to support activities that are incremental to forest renewal obligations that licensees have following harvest. The Minister has specified that the FGRM program receives FFT funding according to its mandate of maintaining Ontario's forest genetic assets, ensuring that genes are conserved and developing trees that are adapted for future growing environments. The benefits of these forest genetic assets and their stewardship provides a valuable resource to the forest management in Ontario and contributes to the CFSA purpose of providing for the sustainability of Ontario's Crown forests.

In accordance with the Forest Management Planning Manual (OMNRF. 2024a) an approved forest management plan establishes the long-term direction for a management unit and describes the forest operations that may occur. The FMPM (OMNRF. 2024a) recognizes climate change as a strategic priority. Of relevance to FGRM, the FMPM describes the requirements for collection of seed and production of nursery stock, tree improvement activities, growth and yield including growth projections (with implications to potential genetic gain) and reporting on expenditures including those under the FFT.

The Forest Operations and Silviculture Manual (FOSM) (OMNRF 2020b), section 2.5 enables the establishment of OMNRF policies on forest genetic resource management. The new Ontario Tree Seed Transfer Policy (OTSTP) was established pursuant to section 2.5. This policy replaces the former Seed Zones of Ontario and provides guidance for seed transfer in a changing climate.

The Forest Information Manual (FIM) (OMNRF 2024b) establishes the mandatory requirements for providing information in respect of Crown forests. Its technical specifications documents are relevant to FGRM.

Ontario's forest legislation and policy framework also includes several guides that establish standards, guidelines and best management practices. The Forest Management Guide to Silviculture in the Great Lakes-St. Lawrence and Boreal Forests of Ontario (Silviculture Guide) (OMNRF. 2015) has considerable relevance to FGRM. Sections of particular relevance are as follows:

> Section 2.2.2 "**Management intensity** is a label used in Ontario's forest management planning process to describe different expectations of future timber yield within each even-aged forest units (sic) and document the anticipated treatment pathways required to achieve them. Increasing intensity generally means increasing site occupancy, control over species composition, implementation of competition control and density management, and may include improved stock."
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> Section 2.3 discusses **Genetic Resource Management**. It notes that "genetic diversity is the basic unit of biodiversity". This section describes the principles of FGRM in relation to natural and artificial regeneration (including tree improvement). It highlights potential concerns with isolated tree populations especially those at the outside of a range.
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> Section 2.4 discusses **Managing for resilience in a changing climate.** It highlights the importance of a species' genetic variability to the resilience of a forest ecosystem in responding to changing environmental conditions.

Ontario's Tree Improvement Master Plan (OMNRF. 1987) establishes one goal and two strategies for tree improvement. The overall goal is to "produce faster-growing and better quality trees by improving the genetic potential of the stock used in artificial regeneration". The two strategies relate to a basic and an intensive program.

Environmental —significant environmental developments

There are **three significant environmental developments** impacting the FGRM program.

The **first of these** and the one with the greatest overall impact is a **changing climate**. A changing climate will potentially affect both wild and improved seed, orchard and test installations, and artificially and naturally regenerated stands. There is considerable ongoing work, provincially, nationally and globally to

explore how the climate is changing, as well as potential adaptation and mitigation efforts. ***The FGRM Program can respond to these changes by initiating collaboration opportunities with potential new partners in areas such as research related to developing genetically improved trees that are adapted to a changing climate, by providing high quality seed or supporting forest managers' seed transfer.***

As part of recent global climate change negotiations at COP27 (UNFCC. 2022) the role of forests and nature-based solutions was prioritized in addressing climate change, reversing the loss of forests and biodiversity and land and ecosystem degradation.

The federal government has released Canada's first National Adaptation Strategy for final comment (GOC. 2022). It is intended as a blueprint for adaptation action to limit the effects of climate change. $3.79 billion in new investments was announced to support climate change adaptation and resilience.

The Government of Canada (GOC) has committed $3.2 billion to support provinces, territories, and third-party organizations to plant 2 Billion Trees over a 10-year period ending in 2031 (GOC. 2022). Resources provided by the 2 Billion Trees program and NRCan's forest adaptation tools and resources could be used by the Associations to support forest managers in addressing climate change. ***The Associations could collaborate in advancing the science, selling high quality seeds and providing consulting services to plant those trees.***

In 2018, the Ontario government released its Preserving and Protecting our Environment for Future Generations: A Made-in-Ontario Environment Plan (OMECP. 2018). It recognizes the need for improving resilience, adapting to climate change and the importance of conserving biodiversity and natural resources. It notes the role that sustainable forest management practices can play in improving the long-term health of Ontario's forests by encouraging growth as well as carbon sequestration in forests and in the products that are produced. Setting forest policy direction that provides for resilient forests and conserves biodiversity (e.g., genetic diversity) is one of OMNRF's strategies to reduce vulnerability of forest ecosystems in a changing climate.

The SFI Forest Management Standard (SFI. 2022) has also introduced an objective for climate smart forestry and is developing resources to support forest managers in meeting objectives such as climate smart forestry. The CSA Standard (CSA Group. 2016) has suggested that certified organizations consider proactive adaptation strategies, including assisted migration and genetic research to create better adapted tree populations.

The **second issue** is the ongoing loss of **global diversity**, including **genetic diversity** and the global response to it.

In developing the strategic direction for the FGRM program, awareness of Ontario's Endangered Species Act and its regulations, Ontario's Biodiversity Strategy, 2023 and the Kunming-Montreal Global Biodiversity Framework (UNEP. 2022) is important. Monitoring federal and provincial government and third-party support for the global biodiversity framework and how it could impact the FGRM program will also be important.

Ontario's Biodiversity Strategy, 2023 notes that greater genetic diversity improves the overall resilience and adaptive capacity of a species to changing conditions such as climate change and new diseases (Ontario Biodiversity Council. 2023).

In responding to threats to biodiversity, the Ontario Ministry of the Environment and Parks (OMECP) establishes standards, guidelines, reference materials and technical resources related to Ontario's Endangered Species Act and its regulations. This direction currently affects the management of various species including ash (black and blue) and butternut.

The three forest management certification standards voluntarily used by forests managers in Ontario address biodiversity and its sub-components, including genetic diversity. The CSA Standard (CSA Group. 2016) specifically states that genetic diversity is to be conserved and that gene-pools are the foundation of species diversity, and as a result diversity of gene pools in seed stocks and effective population sizes in orchards is to be maintained. The FSC Standard (FSC. 2018) states that organizations will use local genotypes unless there is a defensible rationale for using non-local ones. The SFI Standard includes a biological diversity conservation objective that addresses stand and landscape level diversity, and a variety of forest cover types and successional stages (SFI. 2022).

The ongoing role of natural disturbances is the **third issue**. Ontario's forests are affected by natural disturbances, including drought, wildfire, native and invasive pests. ***The FGRM Program offers fundamental opportunities to sustain and improve the forest estate that are not replaced by other mechanisms.*** For example, using genetic improvement to enhance pest resistance or sourcing populations that are more drought and heat tolerant.

Given the forecast for a rapidly changing climate over this century, it is predicted that trees will become increasingly maladapted leading to a reduction in growth rates and increased susceptibility to mortality agents such as drought and pests (e.g., Price et al. 2013, O'Neill et al. 2017). These drought-related impacts are projected to be more widespread in future (Aubin et al. 2018, Lu et al. 2019).

Growth loss and mortality from native pests such as jack pine and spruce budworm and forest tent caterpillar have affected large areas of northeastern and northwestern Ontario. This negatively impacts the timber supply while increasing the fire risk over affected areas. Responses to both budworm species have resulted in extensive and expensive monitoring and treatment programs.

Ontario's forests are also subjected to a continuing onslaught of invasive species. White pine blister rust continues to cause widespread mortality throughout the range of white pine. More recent introductions of invasive pests, such as, butternut canker and emerald ash borer have a continuing and extensive negative impact on Ontario's forests. ***Breeding resistance is one potential area of research to combat these invasive species.***

References

1. **Aubin, I., L. Boisvert-Marsh, H. Kebli, D. McKenney, J. Pedlar, K. Lawrence, E. H. Hogg, Y. Boulanger, S. Gauthier and C. Ste-Marie. 2018.** Tree vulnerability to climate change: improving exposure-based assessments using traits as indicators of sensitivity. Ecosphere 9(2): e02108.
2. **CSA Group. 2016.** National Standard of Canada, CAN/CSA-Z809-16 (R2021) Sustainable Forest Management. Canadian Standards Association. Reaffirmed in 2021.
3. **FSC. 2018.** FSC National Forest Standard. https://ca.fsc.org/ca-en/forest-management
4. **FSC. 2019.** FSC Pesticides Policy. https://ca.fsc.org/ca-en/forest-management/pesticides-policy. Last accessed October 12, 2023.

5. **GOC. 2022.** 2 Billion Trees Program. https://www.canada.ca/en/campaign/2-billion-trees/2-billion-trees-program.html. Last accessed May 24, 2023.
6. **GOC. 2022.** Canada's National Adaptation Strategy. https://www.canada.ca/en/services/environment/weather/climatechange/climate-plan/national-adaptation-strategy/full-strategy.html. Last accessed October 19, 2023.
7. **Lu, P. and D. Derbowka. 2009**. Breeding eastern white pine for blister rust resistance: A review of progress in Ontario. OMNRF. Sault Ste. Marie, ON. September/October 2009, Vol. 85, No. 5 — The Forestry Chronicle
8. **Lu, P., W. C. Parker, S. Colombo, and D. Skeates. 2019.** Temperature Induced Growing Season Drought Threatens Survival and Height Growth in Southern Ontario, Canada. Forest Ecology and Management 448 (2019) 355–363.
9. **Lu, P., W.H. Parker, M. Cherry, S. Colombo, W.C. Parker, R. Man, and N. Roubal. 2014.** Survival and growth patterns of white spruce (Picea glauca [Moench] Voss) rangewide provenances and their implications for climate change adaptation. Ecology and Evolution, 4, 2360–2374.
10. **Lu, Pengxin, William C. Parker, S. Colombo and R. Man. 2016.** Restructuring tree provenance test data to conform to reciprocal transplant experiments for detecting local adaptation. Ontario Forest Research Institute, OMNRF. Sault Ste. Marie, ON. Journal of Applied Ecology 2016. doi: 10.1111/1365-2664.12647
11. **McKenna, J., K. Woeste, and M. Ostry. 2012.** Breeding Resistance to Butternut Canker Disease (Published abstract) p. 209. In Sniezko, Richard A.; Yanchuk, Alvin D.; Kliejunas, John T.; Palmieri, Katharine M.; Alexander, Janice M.; Frankel, Susan J., tech. coords., Proceedings of the fourth international workshop on the genetics of host-parasite interactions in forestry: Disease and insect resistance in forest trees. Gen. Tech. Rep. PSW-GTR-240. Albany, CA: Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture
12. **Office of the Parliamentary Budget Officer (PBO), 2023.** Economic and Fiscal Outlook – October 2023. Office of the Parliamentary Budget Officer, Ottawa, Canada
13. **O'Neill, G., T. Wang, N. Ukrainetz, L. Charleson, L. McAuley, A. Yanchuk and S. Zedel. 2017.** A proposed climate-based seed transfer system for British Columbia. Province of British Columbia, Victoria, BC. Technical Report 099.
14. **Ontario Biodiversity Council. 2023.** Ontario's Biodiversity Strategy 2023-30. Ontario Biodiversity Council, Peterborough, ON.
15. **OMECP. 2018.** Preserving and Protecting our Environment for Future Generations: A Made-in-Ontario Environment Plan.
16. **OMNRF. 1987.** Tree Improvement Master Plan. Ontario Ministry of Natural Resources.
17. **OMNRF. 1994.** Crown Forest Sustainability Act. S.O. 1994, C. 25.
18. **OMNRF. 2010.** Forest Management Guide for Great Lakes-St. Lawrence Landscapes. Queen's Printer for Ontario, Toronto, ON. 57 pp. https://www.ontario.ca/page/forest-management-great-lakes-and-st-lawrence-landscapes. Last accessed October 16, 2023.
19. **OMNRF. 2014a.** A Silvicultural Guide to Managing Southern Ontario Forests. Ontario Ministry of Natural Resources.
20. **OMNRF. 2014b.** Forest Management Guide for Boreal Landscapes. Queen's Printer for Ontario. 104 pp. https://www.ontario.ca/page/forest-management-boreal-landscapes#section-3. Last accessed October 16, 2023.

21. **OMNRF. 2015.** 2015. Forest Management Guide to Silviculture in the Great Lakes-St. Lawrence and Boreal Forests of Ontario. Toronto. Queens Printer for Ontario. 394 pp.
22. **OMNRF. 2020a.** Sustainable Growth: Ontario's Forest Sector Strategy. Ministry of Natural Resources and Forestry. Sault Ste. Marie, Ontario.
23. **OMNRF. 2024a.** Forest Management Planning Manual. Toronto. Queen's Printer for Ontario. 318 pp.
24. **OMNRF. 2020b.** Forest Operations and Silviculture Manual. Queen's Printer for Ontario, Toronto, ON. 21 pp.
25. **OMNRF. 2024b.** Forest Information Manual. Queen's Printer for Ontario, Toronto, ON.90 pp.
26. **Price, D.T., R.I. Alfaro, K.J. Brown, M.D. Flannigan, R.A. Fleming, E.H. Hogg, M.P. Girardin, T. Lakusta, M. Johnston, D.W. McKenney and J.H. Pedlar. 2013.** Anticipating the consequences of climate change for Canada's boreal forest ecosystems. Environ. Rev. 21(4), pp.322–365.
27. **SFI. 2022**. SFI 2022 Forest Management Standard. Sustainable Forestry Initiative. https://forests.org/sfi-2022-standards/ and https://forests.org/forestmanagementstandard/
28. **UNEP (UN Environment Programme). 2022.** Kunming-Montreal Global Biodiversity Framework. Convention On Biological Diversity. https://www.unep.org/resources/kunming-montreal-global-biodiversity-framework#:~:text=The%20conclusion%20of%20the%2015th%20Conference%20of%20Parties,GBF%20aims%20to%20halt%20and%20reverse%20nature%20loss. Last accessed May 24, 2023.
29. **UNFCC (United Nations Framework Convention on Climate Change). 2022.** https://unfccc.int/cop27 and https://unfccc.int/news/cop27-leaders-boost-sustainable-forest-management. Last accessed May 24, 2023.