SCIENTIFIC SUMMARY

Background – Canada's forest industry is faced with new and emerging challenges that erode its long-standing market advantage and threaten economic prosperity. Environmental change, conservation of forest lands, off-shore competition and consumer demand for sustainable products are reshaping the Canadian forestry sector. Genomic science can deliver new tools and information to help Canada regain its position by innovating in sustainable forest management. Species of spruce are dominant in most of Canada's natural and man-made forests. They represent almost 60% of the 650 million tree seedlings planted annually. The current level of spruce plantation will yield 50 to 60 million cubic meters of wood per year, at harvest. Tree selection and breeding programs are a key to deriving benefits from the several $100 million invested to establish these plantations every year. The SMarTForest project will help to improve tree breeding programs by providing innovative tools that are both efficient and effective at addressing present and future challenges.

Research Program - The SMarTForest project will use genomic information to develop marker systems in spruce breeding and sustainable forest management as applied to Canadian forestry programs. These marker systems are aimed at identifying seedlings that possess improved growth and wood properties, and improved insect resistance. We will focus on developing biomarkers for accurate early-age phenotyping, and on the use of genetic markers for marker assisted selection (MAS). The project builds on a decade of international leadership in spruce genomics established by the Arborea and Treenomix projects, and on the extensive genomic resources they have developed. Our research program will utilize promising leads, materials and methods from the previous projects for developing targeted marker systems. The ultimate objective is to validate their potential for tree breeding and forest management, including the conservation of genetic diversity. A supporting major component of the project is sequencing the spruce genome to a "draft" form, using "next generation" sequencing technologies. We are partnering internationally with two other conifer genome sequencing projects in Sweden and in the USA. Integration of our extensive cDNA resources and the proposed genome sequencing will enhance candidate gene approaches for association genetics and biomarker development, and enable novel genome-wide and comparative analyses. The combined outcomes will enable both short-and longer term opportunities for applied forest genomics in Canada.

Impact Analyses - The GE[3]LS program of the SMarTForest project will develop more accurate models of the economic impact of genomic-based selection technologies and analyze anticipated gains related to growth, wood quality and insect resistance. We will develop a supply chain simulation/optimization tool for "genetically selected plantations" for forest and community managers. We also aim to develop a better understanding of the challenges facing potential end-users of genetic marker systems and improved

varieties, as well as the legal and policy instruments that could impact the use of MAS in provincial jurisdictions.

Benefits to Canada - The SMarTForest project is in collaboration with Canadian end-users from government and industry, and utilizes trees and information from active tree breeding programs in British Columbia, New Brunswick and Quebec. Through active participation of end-users and integration of a GE^{3}LS program, the SMarTForest project is not “incremental”, but will provide novel avenues for tree breeding, forest management, and conservation in Canada. The short term benefits from the SMarTForest project are new tools and services ready for application by the end of the 3-year project, as well as trained highly qualified personnel. Over a horizon of 510 year from now, we expect that our MAS methods will be fully integrated in improved tree breeding strategies. Longer term benefits of industry competitiveness and economic prosperity will be derived from superior yield and value recovery that are expected from spruce plantations.