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North America: Regional Synthesis on the State of the World's Forest Genetic Resources

PART 1 - Regional factsheet:

1.1 Importance of forests to the region's economy, food security, and climate change adaptation

1.1.1 Regional context

North America is the third largest continent, covering 24,346,000 km^2 (Food and Agriculture Organisation (FAO), 2011) and consisting of three countries: Canada, Mexico, and the United States of America (USA). Canada occupies most of the northern part of the continent, except for the very northwest portion, which is the largest US state, Alaska (Fig. 1). Mexico and the USA, respectively, make up the southern and central portions of the continent, and there are numerous smaller US territories in in the Caribbean (Puerto Rico and the US Virgin Islands). For the purposes of this report, North America refers to Canada, Mexico, and the USA (excluding US territories in the Pacific and Hawaii)[1].

Canada is a federal state consisting of 10 provinces and three territories; it covers approximately 9,093,507 km^2 (Natural Resources Canada, 2012). The Republic of Mexico consists of 31 states and one federal district, covering approximately 1,943,945 km^2 (Améndola et al., 2002) (Fig. 1). The USA is a federal republic of 50 states, one federal district (District of Columbia) and offshore territories in the Caribbean and Pacific, including Puerto Rico and the US Virgin Islands; it covers approximately 9,158,960 km^2 (excluding its territories) (United States Geological Survey, 2013) (Fig. 1).

At 8,891 km and stretching across both land and water (Government of Canada, 2010), Canada and the USA share the longest international border in the world between the same two countries. The Mexico–US border is 2,475 km (Government of the United States of America, 2006). Spanning these borders are shared forest types, such as red pine (*Pinus resinosa* Ait.), sugar maple (*Acer saccharum* Marsh.), yellow birch (*Betula alleghaniensis* Britt.), and white pine (*Pinus strobus* L.) in the Great Lakes–St. Lawrence Forest Region (Rowe, 1972) and temperate broadleaf forest types in the Appalachians for Canada and the USA (Bowers and McKight, 2012). Mexico and the USA share species in the subtropical mountain system (Fig. 1). These three countries also share many natural resource challenges, including the threats posed by climate change, fire, and invasive species (United States Department of Agriculture Forest Service (USDA FS), 2000a).

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[1] The *Country Report on the State of Forest Genetic Resources in the United States of America* (2013) included species from Hawaii, but this regional report does not. As a result, the data presented in this report for the US may not be the same as data presented in the USA Country Report.

1.1.1.1 Physiographic Regions

North America is divided into at least five major physiographic regions, including the Appalachian Mountains, the Atlantic Coastal Plain, the Canadian Shield, the Interior Lowlands, and the North American Cordillera. The Appalachian Mountains extend from the Gaspé Peninsula in Canada to Alabama in the USA (Clark, 2008) and are North American's oldest mountain range. The Atlantic Coastal Plain is a belt of lowlands that are wide and extend south from New England in the the USA into Mexico. The Canadian Shield occupies most of the northeastern quadrant of the continent and is a geological core area containing North America's oldest rock. The Interior Lowlands extend from the middle of the continent down to the Atlantic Coastal Plain and are covered mainly by glacial debris. The North American Cordillera is a complex group of mountains that run south from Alaska through Mexico to the connected Transverse Volcanic Ranges, a zone of high and active volcanic peaks south of Mexico City. The highest peak in North America is Mount McKinley, Alaska (6,194 m). Mexico is unique in North America as two biogeographical regions, the nearctic and neotropical, meet there, and the integration of these regions combined with Mexico's rugged geography help create multiple microclimatic and isolated areas that have shaped Mexico's significant biological diversity (Huppe, 2010).

North America extends to within 10^{o} latitude of the equator; climatically, the temperature varies latitudinally, becoming colder as one moves north. North America includes multiple climatic zones, from tropical rain forest and savannah in Mexico to the permanent ice cap in the arctic region (e.g., parts of Ellesmere Island, Canada). Precipitation, although variable, generally tends to decline toward the west, except for the Pacific Coastal strip, which can receive a high amount of rainfall. This is known as the Rain Shadow Effect, where moisture-laden air moves onshore from the Pacific and is unable to penetrate the continent because the high mountains (e.g., the Rocky Mountains in Canada) block the passage of rain-producing weather systems; consequently, western North America east of the Rockies tends to be dry (Siler et al. 2013).

Figure 1. Political Map of North America[1]

[1], From EZILON Maps, available online at: http://www.ezilon.com/maps/north-american-continent-maps.html Accessed June 2013.

1.1.1.2 North American Forest types

North America represents 16% of the world's land area and 17 % of the world's forests (FAO, 2007) and contains some of the world's most productive forests (FAO 2010a, b, c). Thirty-three percent of the land area is forested (FAO, 2007). Highly varied climatic conditions have led to diverse and, in some cases, unique forest ecosystems. Forest types of the boreal, temperate, and tropical zones of the world are present (Fig. 2; Table 1). Of these forest types, primary[2] forests account for 45% of the forests in North America (FAO, 2007). Forest area in the region is reasonably stable (FAO, 2007). In Mexico, there is concern about the continuing loss of forest, although the percentage is less significant than that of other countries (FAO, 2010c).

The distribution of forest types in North America is primarily influenced by latitude (Society of American Foresters 2010; Fig. 2). North America contains many diverse forest types. The northern boreal forest

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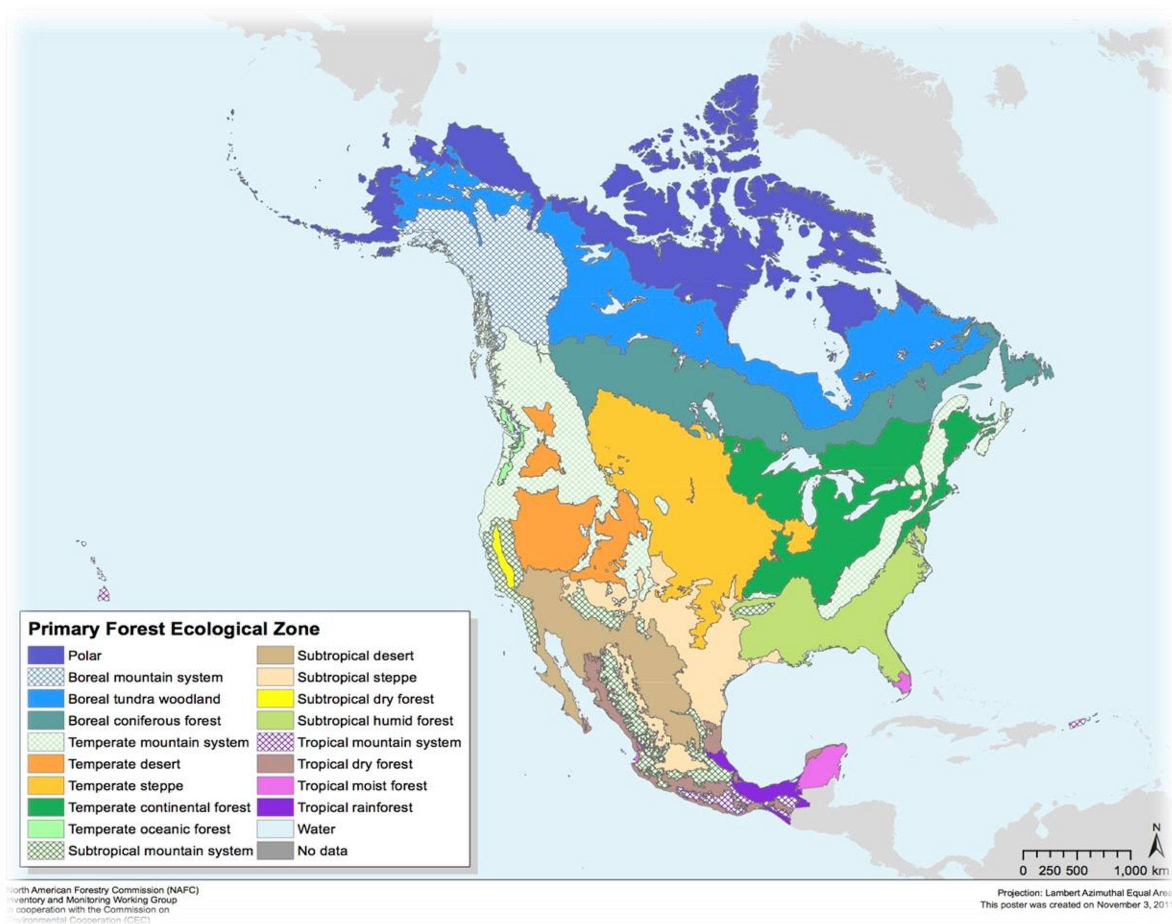
[2] A primary forest is a forest, regardless of its age, that has developed following natural disturbances and under natural processes and has never been logged (http://www.cbd.int/forest/definitions.shtml, accessed 8-8-2013)

contains primarily conifers, such as *Abies* spp., *Larix laricina, Picea* spp., and *Pinus* spp. at the highest latitudes in Canada and the USA (Alaska). The mid-latitude of Canada and most of the USA consists of temperate forests, with pure and mixed stands of conifers and deciduous species (e.g., *Acer* spp., *Fraxinus* spp., *Pinus* spp., *Quercus* spp.). Species diversity is higher in the southern-most regions. The temperate rainforests of the west coast support a wide variety of life and are dominated by species such as *Picea sitchensis*, *Pseudotsuga menziesii*, and *Thuja plicata*. Mexico is the center of diversity and distribution of such genera as *Pinus* spp. and *Quercus* spp., with more than 50 species of pine and 200 species of oak having been identified; over 70% of these species are native to Mexico (FAO, 2013c). Mexico has subtropical and tropical forest species (e.g., *Cedrela ordorata*, *Gliricidia sepium*, *Swietenia macrophylla*).

Figure 2. North American Forest Types[2]



[2] From Forest Types of North America, The Commission of Environmental Cooperation. Available online at: http://www.cec.org/Page.asp?PageID=924&ContentID=25137 Accessed June 2013.

1.1.2 Contribution of forest genetic resources to socioeconomics, poverty reduction, and food and nutrition security

The unique history of these countries has led to important economic, institutional, and social differences, all of which are directly or indirectly reflected in the forest situation (FAO, 2008). Common regional uses for forests, in addition to timber, include firewood, hunting, materials for handicrafts, medicines, recreation, and seeds and fruits for food. Forests also play a key role in providing clean water in all three countries.

Mexico has a long history of community management of natural resources under Ejidos, which are areas of communal land used for agriculture (FAO, 2013c). Approximately 13 million people live in Ejidos and indigenous communities in different forest regions (CONAFOR, 2009). Some of these people have created forest-based community companies, and other communities continue to use the natural resources in traditional ways. Logging is a major source of employment for those living in forested areas, and firewood is the main source of energy for cooking and for heating their homes.

Forest genetic resources (FGR) contribute to agricultural sustainability, economic development, food security, and poverty alleviation in Canada, Mexico, and the USA (FAO, 2013a,b,c). In particular, mast (nut or seed) crops and fruit trees are important sources of food and have special importance for indigenous peoples. Additionally, some people rely on non-timber forest products (NTFPs) as a source of income.

Non-timber forest products contribute to the economy of the three countries, with forest tree species having diverse uses (e.g., *Acer macrophyllum*, *A. saccharum, A. negundo,* and *A. nigrum* are used to produce maple syrup in Canada and the USA; *Pinus lambertiana* cones are used for crafts in the USA; *Taxus brevifolia* is harvested, primarily in Canada, to produce Taxol®, a chemotherapy agent; various *Abies*, *Pinus*, and *Picea* spp. are harvested in Canada and the USA for Christmas trees; various *Pinus* spp supply edible nuts in Mexico and the USA). The largest group of *Pinus* species producing edible nuts are piñon pines found in northern Mexico and southwestern USA, with approximately 13 native species of known value (Lanner, 1981). Pine nuts are a traditional food for indigenous peoples and also are important for trade. Examples of sub-regional North American *Pinus* spp. producing edible nuts include *P. cembroides*, *P. monophylla*, *P. monticola,* and *P. remota* in Mexico and the USA, and *P. albicaulis, P. flexilis*, and *P. ponderosa* in western Canada and the USA.

Indigenous peoples of the region have unique cultures, lifestyles, and values that can vary between groups. However, a common consideration is their spiritual relationship with the ecosystem or forest. This view of nature can influence their land management practices (Jostad et al., 1996). Certain FGRs also have cultural and spiritual significance for indigenous peoples. For example, *Cedrela odorata* (Mexico), *Ceiba pentandra* (Mexico), *Fraxinus nigra* (Canada), *Sequoia sempervirens* (USA), *Thuja occidentalis* (Canada, USA), and *Thuja plicata* (USA) are used by indigenous peoples in the region for traditional purposes (e.g.,basketry, fiber source, medicinal uses) (Moerman, 1998). Additionally, cultural and spiritual values can reside within forested areas (e.g., Haida Gwaii in Canada). These forest values and FGRs are not unique to indigenous peoples; they are often shared by others and can be incorporated into national policies. For example, the US Wilderness Act refers to a wilderness as "an area where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain." Additionally, a wilderness is "an area which provides opportunities of solitude" (United States of America, 1964). The language can be interpreted as advocating a particular reverence for these wilderness areas.

In Mexico, the Forest Strategic Program 2025 acknowledges that the management and sustainable use of forest resources play an important role in reducing poverty and the degradation of natural resources (FAO, 2013c). In rural populations, which are disproportionately affected by poverty, forest resources have direct benefits to rural resource owners by providing food and employment. For example, rural people in Sierra Tarahumara, Mexico, which has an estimated population of 370,000, depend on forest resources and manage the forest for diverse purposes (FAO, 2013c).

1.2. FGR management and uses /forest resources management systems

1.2.1 Overview

Forest ownership patterns have an important role in the management and use of FGRs. There are ownership differences among the three countries. Most of Canada's land is publically owned (93%), with 77% under provincial or territorial jurisdiction, 16% under federal jurisdiction, and 7% privately owned by more than 450,000 landowners (FAO, 2013a). In Mexico, 5% of the forest land is owned by the federal government, 15% is privately owned, and 80% of the forest is under common ownership, which includes communal lands and Ejidos, under the management of indigenous groups (FAO, 2013c). In the USA, approximately 54% of the forest land is privately owned, with approximately two-thirds owned by individuals and families and one-third by corporations/companies (FAO, 2013b). Public forests tend to be dominant in the western USA, whereas private forests are dominant in the eastern USA.

Forest products are important to the region's national economies. North America, in particular Canada and the USA, continues to be the world's top producer, consumer, and exporter of forest products (FAO, 2010a,b). A number of forest species contribute to important commodities in the region, including energy/fuelwood, environmental services, food, NTFPs, paper and pulp, and, timber. Additionally, forests in the region provide a range of goods and services (e.g., air purification, maintenance of wildlife habitat, nutrient cycling, and water) and contribute to national economies through employment in forest-related industries (e.g., recreation, tourism).

The three countries have used a variety of parameters to identify priority species, species that have conservation, cultural, ecological, economic (e.g., reforestation, NTFP), and social importance (Table 2). In Canada, the report on *The State of Canada's Forest Genetic Resources* (Natural Resources Canada, 2012) defines priority species as those species actively managed for productive aims and ecological services. These species also include those that are a conservation priority (FAO, 2013a). There are approximately 64 Canadian priority tree species[3] (Tables 1, 2). In Mexico, the Comisión Nacional para el

Conocimiento y Uso de la Biodiversidad (CONABIO) and Comisión Nacional Forestal (CONAFOR) identify 294 priority species, and 37 species are specifically reported on in the report on *Forest Genetic Resources in Mexico* (Mexico, 2012; FAO, 2013c) (Tables 1, 2). In the USA, 122 species are considered priority, with 100 species identified as important for reforestation for economic (top 20 species in standing volume) and/or ecological reasons (simply defined as species with restoration programs, albeit many for timber production); 22 species that have official national-level risk (and are not native to Hawaii) designations or have active federal conservation programs (*Fraxinus nigra* and *F. quadrangulata*)(Table 2).

Regionally, approximately 185 species are considered a priority in at least one country, and approximately 140 of these species are subject to selection, evaluation, and improvement activities (Tables 2, 3). All priority species in Mexico were considered a priority for two or more reasons, whereas in Canada and the USA, the majority of species were a priority for one reason (Table 2). By region, the majority of species identified as a priority were for ecological reasons (41%), followed by economic (16%), ecological, economic, and social (16%), economic and ecological reasons (15%), and social reasons (12%)(Table 2).

Canada and the USA have 38 species that are priorities in both countries (Table A below). Mexico and the USA have only one priority species in common, *Pseudotsuga menziesii*, which is also a common priority species to all three countries. *Pseudotsuga menziesii* is considered a priority for economic, environmental, and social reasons (Table 3). It is an ecologically highly variable species with substantial local adaptation, which makes it very interesting for studying adaptation and the effects of global climate change. Extensive work is being done on this species in all three countries, which all have breeding and domestication programs.

Table A. Priority species common to both Canada and the USA[3]		
Abies amabilis	*Larix occidentalis*	*Picea engelmannii*
Abies balsamea	*Picea glauca*	*Populus balsamifera* x *trichocarpa*
Abies grandis	*Picea mariana*	*Populus tremuloides*
Abies lasiocarpa	*Pinus albicaulis*	*Pseudotsuga menziesii*
Abies procera	*Pinus banksiana*	*Quercus bicolor*
Acer rubrum	*Pinus contorta*	*Quercus alba*
Acer saccharum	*Pinus contorta* var. *latifolia*	*Quercus macrocarpa*
Betula alleghaniensis	*Pinus flexilis*	*Quercus rubra*
Carya ovata	*Pinus monticola*	*Thuja occidentalis*
Fraxinus americana	*Pinus ponderosa*	*Tsuga canadensis*
Fraxinus nigra	*Pinus resinosa*	*Tsuga heterophylla*
Fraxinus pennsylvanica	*Pinus rigida*	*Ulmus americana*
Juglans cinerea	*Pinus strobus*	

[3] Data are derived from Table 2.

1.2.3 Management systems and trends

Different conservation strategies and practices are implemented across the region. *In situ* and *ex situ* conservation are important strategies for the conservation of forests and are well supported through multiple activities. Forest research is also playing an increasingly important role in forest management, reducing of the impact of stresses on FGRs, and the conservation of these resources.

1.2.3.1 In situ conservation

All three countries have variable forms of *in situ* conservation encompassing a wide range of approaches, mechanisms, and protected areas. In Canada, 975,816 km^2 (97,581,600 ha), are considered *in situ* conservation areas (designated parks or other ecological reserves) with an estimated additional 30,000 km^2 (3,000,000 ha) of privately owned land under conservation-oriented management (FAO, 2010a). In Mexico, there are 174 protected natural areas (PNAs), covering a total area of 253,867 km^2 (25,386,748 ha), of which 207,759 km^2 (20,775,926 ha) are land based (FAO, 2010c). In the USA, 752,770 km^2 (75,277,000 ha) of forested area are identified for the conservation of biodiversity, and 303,250 km^2 (30,325,000 ha) are identified as forest area within protected areas (FAO, 2010b). Based on the 2010 FAO's Forest Resources Assessment country reports, Canada (FAO, 2010a), Mexico (FAO, 2010c), and the USA (FAO, 2010b) have reported on a total per country of 24,859,000 ha, 8,488,000 ha, and 30,225,000 ha, respectively, as forested areas within protected areas, for a total of 63,572,000 ha for North America. Forested areas within protected areas are defined as "forested area that is designated to be retained and may not be converted to other land use" (FAO, 2010b).

Often, as is the case in Canada, *in situ* conservation and protection of biological diversity are not centrally planned. Canada has numerous categories of protected areas established through different organizations at the federal and provincial/territorial levels and through non-governmental organizations that either directly or indirectly aim to conserve tree species (FAO, 2013a). In 1992, it was determined that approximately 225,000 km^2 of forests are within the various parks or ecological reserve systems, representing approximately 4.9% of the total forest areas in Canada. In the USA, there are private protected forests in various forms of conservation easements and fee simple holdings by non-governmental organizations; these mechanisms ensure that these private lands are given some legal protection (FAO, 2013b). In the USA, 14% of forests are currently protected under wilderness of similar status, and this number has changed little since last reported in 2003 (FAO, 2013b). The increased use of protection easements and similar instruments on private lands indicates that the total area of forests under some form of protection is increasing. Also during the past century in the USA, losses of forest land in some areas (in particular those adjacent to urban areas) have been offset by gains in others (e.g., abandoned agricultural land returning to forest).

In contrast, in Mexico, *in situ* conservation is centrally managed through the National Commission on Protected Natural Areas (CONANP) and is intended to conserve habitats with minimal or no human intervention and to promote the evolution of species within ecosystems (FAO, 2013c). The number of PNAs has been increasing, mainly in the Biosphere Reserves and Areas of Flora and Fauna Protection. Most PNAs include more than one type of vegetation, and not all include forested areas. Tropical deciduous forests and conifer forests are found in 79 and 46 PNAs, respectively, whereas oak forest and cloud forest were found in 47 and 37 PNAs, respectively. The Mexican Department of Wildlife, SEMARNAT, promotes conservation through the establishment of Wildlife Management Units (WMU), which are property of the owners or license holders, and they are required to operate in accordance with approved management plans that monitor populations or individuals distributed within the WMU. The WMU may have multiple objectives, including maintenance, protection, reproduction, rescue, restoration, and sustainable use.

The three countries have a memorandum of understanding (MOU) on the Cooperation for Wilderness Conservation between seven agencies responsible for wilderness management: (1) Parks Canada Agency of the Government of Canada; (2) the Secretariat of the Environment and (3) Natural Resources through the National Commission on Protected Natural Areas (CONANP) of the United Mexican States; and (4) the National Park Service; (5) Fish & Wildlife Service; (6) Bureau of Land Management; and (7) the Forest Service and Office of Ecosystem Services and Markets of the US Department of Agriculture (The WILD Foundation, 2003) in the USA. The MOU which was signed in 2009 has provisions that address ecosystems, migratory wildlife, and natural resources that do not start and end with geographical borders. This MOU addresses north–south biological corridors and encourages cooperative efforts to conduct and share scientific research.

1.2.3.2 Ex situ conservation

Ex situ conservation in North America includes multiple types of collections, including arboreta, botanical gardens, conservation stands, in vitro accessions (e.g., pollen and tissue culture), provenance and progeny trials, and seed.

There are strong North American national capacities to conserve seed and *in vitro* accessions for long-term storage. In Canada, there are five (one national and four provincial) main forest gene banks; the federal storage center has a capacity to store approximately 1.5 tonnes (FAO, 2013a). Germplasm from 82 tree species are stored in Canadian collections. In Mexico, there are 37 forest gene banks for medium-term storage and 17 centers for temporary storage, with a collective capacity to store 235 tonnes (FAO, 2013c). Numerous forest tree species are represented in seed storage collections in Mexico, such as, *Pinus patula* (240 accessions) and *Pinus greggii* (437 accessions) (FAO, 2013c). In the USA, the National Plant Germplasm System (NPGS), run by the US Department of Agriculture, Agricultural Research Service, is the primary gene conservation agency (FAO, 2013b). A component of the NPGS, the National Center for Genetic Resources Preservation, maintains the long-term storage of seed and *in vitro* cultures. The NPGS maintains 95 genera in 23,274 accessions of tree and shrub species. Other seed storage programs also exist, which include arboreta and botanic gardens and short-to-medium storage of restoration seed lots by state and federal agencies. All three countries use primarily conventional seed storage methods, but also use cryopreservation for species that produce seed that cannot be stored long term using conventional means (e.g., *Juglans cinerea*) and for tree pollen.

All three countries also maintain *ex situ* conservation in plantations and clone banks for multiple species, and have restoration and breeding programs that contribute to the *ex situ* conservation of FGRs. Examples include breeding and restoration/regeneration programs for *Abies lasiocarpa*, *Pinus flexilis*, *Populus deltoids*, and *Quercus macrocarpa* in Canada, *Callophyllum brasiliensis*, *Cedrela ordorata*, *Hevea brasiliensis*, *Pinus cembroides*, *Pinus patula*, and *Swietenia humilis* in Mexico, and *Castanea dentata*, *Larix occidentalis*, *Pinus albicaulis*, *Pinus contorta*, *Pinus palustris*, and *Quercus alba* in the USA (FAO, 2013a,b,c). Canada and the USA have collections for numerous *Abies*, *Larix*, and *Pinus* spp., and Mexico and the USA have collections for *Cupressus lusitanica* and *Liquidambar styraciflua.* All three countries have *Pseudotuga menziesii* collections. In total, over 140 species are represented in breeding and restoration programs in the region (FAO2013a,b,c).

There are multiple *ex situ* national conservation programs. In Canada, there is no national *ex situ* conservation program; however, CON**FOR**GEN, (a pan-Canadian program for the Conservation of Forest Genetic Resources) assists in providing national-level conservation information that contributes toward conservation activities (FAO, 2013a).The USDA Forest Service supports a number of conservation programs that often form part of reforestation or forest tree breeding programs (FAO, 2013b). These programs include national, state, and private forestry efforts. In Mexico, the National Center for Genetic Resources officially opened in 2010, with one of their goals being to preserve and improve FGRs (FAO, 2013c).

Although there are no regional programs, there are species-targeted regional *ex situ* conservation efforts. For example, the USDA Forest Service and the USDA ARS NPGS, in collaboration with the Canadian Forest Service's National Tree Seed Centre, cooperate toward the long-term conservation of *Fraxinus* spp. (e.g., *Fraxinus americana*, *F. nigra*, *F. pennsylvanica*, *F. profunda* and *F. quandrangulata*), which are threatened by an invasive species, the emerald ash borer (*Agrilus planipennis*). Additionally, the North American Forestry Commission's (NAFC), Forest Genetic Resource Working Group (FGR-WG) has promoted efforts such as the conservation of endangered *Picea* taxa in Mexico and the southwestern USA ,and the conservation of *Pinus radiata* in Guadalupe and Cedros islands (Mexico) and in California (USA).

1.2.4 Indicators for sustainable management

Currently, there are no regional-level indicators for sustainable management of FGRs. However, at the national scale, Canada, the USA and Mexico have endorsed the Montreal Process Criteria and Indicators for the conservation and sustainable management of temperate and boreal forests. All three countries have produced technical reports describing their capacity to report in this area. Changes in the natural, planted, and total forest area provide coarse-level indicators (Table 1), whereas at the species level, species diversity and conservation activities provide information pertaining to biological diversity, and economic and social benefits provide finer-level indicators of change (e.g., data presented in Tables 2, 3, 4). Data presented in these tables, monitored over time, can provide the information for regional-level indicators for sustainable management. More detailed information can be found in each country's Montreal Process report.

Recently, the FAO and four of the major Criteria and Indicator processes have taken steps to streamline global forest reporting by developing a new Collaborative Forest Resources Questionnaire that better aligns the data collection requirements and schedules between the FAO's Global Forest Resource Assessment and the C&I processes. This questionnaire is being used by over 100 countries to collect data for the FAO's 2015 Global Forest Resource Assessment and could be an additional source of consistent global information for reporting on the sustainable management of FGRs.

1.3. Forest Genetic Resources

1.3.1 Status

1.3.1.1 Genetic variation of species and species populations

There are regional and extensive national-level activities pertaining to the identification of genetic variation in species and populations (see Table 3). Regional-level activities assessing genetic diversity of species such as *Pseudotsuga menziesii*, whose natural range spans all three countries, occur nationally and also through regional collaborations such as those facilitated by the FAO's Fourth American Forestry Commission's (NAFC) Forest Genetic Resources-Working Group (FGR-WG) (Table 5). The FGR-WG also addresses the impact of climate change on tree species of common interest. This working group is highly beneficial for accomplishing regional-level activities associated with FGRs.

Canada, the USA, and Mexico do not have national-level policies pertaining to the study or to the development of inventories of genetic variation of tree or shrub species (FAO, 2013a,b,c). However, there are significant efforts to study and assess the genetic diversity of forest species and species vulnerability to various stresses, among other things, at both the national and regional levels (Table 4). In Canada, the genetic diversity of a number of commercial (e.g., *Picea glauca*, *Picea mariana*, *Pinus contorta, Pseudotsuga menziesii*) and non-commercial (*Juglans cinerea, Pinus albicaulis*, *Quercus garryana*) tree species has been assessed (FAO, 2013a). In Mexico, projects are supported by the National Council of Science and Technology (CONACYT) and the National Commission for Knowledge and Use of Biodiversity (CONABIO) federal agencies, and internationally, through such organizations as the International Program for the Breeding and Conservation of Forest Species and the USDA Forest Service (FAO, 2013c). CONABIO has funded 47 projects related to resource studies on floristic inventories (study of the number, distribution, and relationships of plant species) and the analysis of species with economic potential and useful species for reforestation (CONABIO, 2012). The genetic diversity of a number of forest species of economic importance and wide distribution has been assessed in such species as *Abies religiosa, Cedrela ordorata*, *Pinus greggii*, *Pinus leiphylla*, *Pinus oocarpa*, *Pinus patula*, *Pinus pinceana*, *Pseudotsuga menziesii* (FAO, 2013c). In the USA, genecological studies have mapped the genetic variation of species across the landscape, primarily in the Northwest (e.g. *Pinus contorta*, *Pinus monticola*, *Pseudotsuga menziesii*, *Thuja plicata*)(FAO, 2013b). These studies have evaluated adaptive traits and their relationship to the pattern of variation, clinal versus ecotypic. Current research has found that “on the basis of the patterns of quantitative variation for 19 adaptation-related traits studied in 59 tree species (mostly temperate and boreal species from the Northern hemisphere) that genetic differentiation between populations and clinal variation along environmental gradients were very common (respectively, 90% and 78% of cases)” (Alberto et al. 2013). This suggests that many tree species native to North America show patterns of adaptive variation.

All three countries have a national policy pertaining to the identification of forest species at risk. In Canada, 11 tree species are identified as endangered, threatened, or of special concern (Committee on the Status of Endangered Wildlife in Canada (COSEWIC), 2011; FAO, 2013a). In Mexico, there are 117 tree and shrub species included in their NOM-059-SEMINAR-NAT-2010 risk categories (NOM-059-SEMINAR-NAT-2010, SEMARNAT, 2010; FAO, 2013c). In the USA, 57 trees and shrubs are officially listed as threatened or endangered by the Department of Interior Fish and Wildlife Service[4], with most of these species being tropical (FAO, 2013b). These species, which have national-level risk designation, are referred to as *high* priority species (Table 4), whereas those identified in the country reports as “priority species” are referred to as priority species.

All Canadian tree species (height ≥10 m) have natural ranges that extend into the USA. The degree to which this occurs varies; for example, approximately 99% of the range of *Fraxinus quadrangulata* is in the USA, whereas for *Picea rubens*, most of the range is in Canada with only small disjunct populations found in the USA. The ranges of a few species, including *Cornus florida*, *Ostrya virginiana*, *Pinus contorta*, *Pinus flexilis,* and *Pseudotsuga menziesii* span the three countries. Mexico and the USA have numerous species whose ranges span the two countries, including *Pinus cembroides*, *Picea engelmannii*, *Quercus rugosa*, *Quercus virginiana*, *Rhizophora mangle*, and *Simarouba glauca*. The US Department of the Interior, US Geological Survey has developed and made available distribution maps for most tree species that span the three countries (United States Geological Survey, 2013).

1.3.1.2 Traditional knowledge of species and ethnobotany

Traditional knowledge and ethnobotany of North American tree species can be divided into five major categories: drug, dye, fiber, food, and other uses (Moerman, 1998). The drug category is by far the most documented. There are approximately 291 groups of indigenous peoples identified in North America according to Daniel Moerman’s work on ethnobotany (1998).

[4] This includes species at risk in Hawaii. Table 5 does not include Hawaiian species at risk.

In assessing the North American region's priority species, there are eight tree species that have natural ranges spanning all three countries (Table 2). These are *Fagus grandifolia*, *Ostrya virginiana*, *Pinus contorta*, *Pinus ponderosa*, *Platanus occidentalis*, *Prunus serotina*, *Pseudotsuga menziesii*, and *Quercus muehlenbergii*. As examples of their varied uses, *Ostrya virginiana* is used primarily for medicinal purposes (e.g., antirheumatic, astringent, and blood tonic). *Pinus contorta* is used for medicinal purposes (e.g., antiseptic diuretic, blood purifier, poultice), as a fiber source, and for various other uses (e.g., adhesive, basket making, water proofing, etc.) (Moerman, 1998). *Pseudotsuga menziesii* is used for a variety of purposes, including drug, fiber, food, and other uses (fertilizer, insecticide). Single logs were used to make dugout canoes, and the pitch was used as caulking and gum.

There are number of tree species whose natural ranges span only two countries of the region (Table 2). Canada and the USA share the largest number of species with ethnobotanical uses. In total, 54 species are represented, split almost equally between hardwoods (29) and softwoods (25), with *Pinus* (eight species), *Picea* (six species) *Populus* (six species), *Quercus* (five species), and *Abies* (four species) being the most represented in terms of genera. *Quercus* is used mainly as a food source, where the acorns were eaten or ground into a powder and incorporated into breads. *Abies* spp. are mainly used as a drug. There are eight species whose ranges fall within Mexico and the USA.

1.3.2 Threats to forest genetic resources in the region (forest degradation, expansion of agricultural land, over-exploitation, free grazing, climate change)

All three countries have identified forest health as an important issue and have worked collaboratively to address transboundary issues in this area (FAO, 2013a,b,c). Working groups (WG) under the NAFC address cross-border issues and direct WG research efforts address fire, forest insects and diseases, genetic resources, and invasive species.

Common regional threats to FGRs include changing land use, climate change, forest fragmentation, and indigenous and exotic pests and diseases. Canada and the USA cite climate change as a serious threat impacting physical and biological environments (FAO, 2013a,b). The impacts of climate change have already been observed in both countries, with an increase in the frequency and severity of natural disturbances such as wildfires, pest and disease outbreaks, droughts, and at a more subtle level, changes in phenology and an alteration in some species' ranges (FAO, 2013a,b).

Climate change can impact pests, diseases and fires in often unpredictable ways. Insect populations in the US and Canada are increasingly at unprecedented densities as a result of longer growing seasons and warmer climates. The mountain pine beetle (*Dendroctonus ponderosae* Hopkins) is a native insect of the pine forests of western North America. Mild winters and droughts have contributed to an unprecedented extent and severity of beetle outbreaks (FAO, 2013b). Additionally, forest fires have a significant impact on forest health in all three countries. Increasing fires are also resulting in an increased need for planting stock for restoration (FAO, 2013b).

North American forests have been subject to pressure from exotic pest and disease outbreaks, including the Asian longhorn beetle (*Anoplophora glabripennis*) and emerald ash borer (*Agrilus planipennis*) in Canada and the USA, and *Dendroctonus frontalis* in the southern parts of the USA and in northern parts of Mexico (Payne, 1980). Furthermore, the disease Eucalyptus rust (*Puccinia psidii*) is impacting forests in Mexico and the USA (Grgurinovic et al. 2006). The extent and intensity of outbreaks can be impacted by other disturbances such as extreme weather, fire, or human activity (FAO, 2007). The USA has identified more than 450 exotic insects and at least 16 pathogens that have colonized forests and urban trees since European settlement (FAO, 2013b). At least 60 of these insects and all of the reported pathogens have caused notable damage to trees.

In Mexico, an estimated loss of 50% of cloud forests, and high and medium evergreen forests are threatened by disturbances associated with harvesting activities since the 1960s (FAO, 2013c). Mexico noted that illegal exploitation is an additional threat to forest areas.

1.3.3 Region-specific resources highlighted

1.3.3.1 Examples of organizations and activities promoting regional-level action

The NAFC was established in 1958 to provide a policy and technical forum for Canada, Mexico, and the USA to address forest issues on a regional basis (Table 5). Within the NAFC is the FGR-WG, which has the mandate to "generate, share, and disseminate knowledge that is crucial for the conservation and the sustainable use of North American FGRs for the benefit of present and future generations." The FGR-WG has three objectives: (1) to promote the collection, exchange, and dissemination of information about FGRs so that *in situ* and *ex situ* programs of conservation and sustainable use are based on sound scientific knowledge, (2) to promote cooperation and coordinate research, conservation, training, and exchange among member countries on genetic resource conservation problems, and (3) to facilitate the international exchange of FGRs (USDA Forest Service, 2000b).

The North American Plant Protection Organization offers a mechanism for regional coordination on phytosanitary matters. This organization provides an effective regional-level forum for the public and private sectors in Canada, the USA, and Mexico to collaborate in the development of science-based standards intended to protect agricultural, forest, and other plant resources against regulated plant pests, while facilitating trade. All three countries also consistently share information through national-level fire programs (e.g., Active Fires Mapping Program in the USA and the Canadian Wildland Fire Information System) as well as resources to prevent or minimize the impact of fires.

1.3.3.2 Biodiversity hotspots

The Pacific Coastal Temperate Rainforest Region, which spans Canada and the USA, accounts for the largest proportion of the world's coastal temperate rainforest, representing 50% of the global distribution (Lawford et al., 1995). Furthermore, Mexico and the California Floristic Province in the USA are identified as biodiversity hotspots, with 1.7% and 0.7% of global plants, respectively (Myers et al. 2000). Mexico is one of 12 countries recognized as megadiverse and is ranked the fourth-most biodiverse country in the world (ARD Inc. and Darum, 2003). Mexico's forests represent an important component of this diversity, with approximately 80% of Mexico's vascular plants and 75% of its vertebrates (Bray and Merino-Perez, 2002). Diversity is higher in the southern tropical regions; however, endemism is higher in the northern temperate zones (World Bank 1995).

1.3.3.3 Transboundary conservation zones

Transborder cooperation and the regional-level management of protected areas is increasing. Several agreements are in place between Canada and the USA. For example, the Waterton Lakes National Park (Alberta, Canada) is linked to Glacier National Park (Montana, USA), and these parks form the world's first International Peace Park (FAO, 2013a). In addition, large corridor initiatives such as the Yellowstone–to–Yukon Conservation Initiative conserve large *in situ* forested regions, with the goal of linking ecosystems among two provinces and two territories in Canada and five states in the USA (FAO 2013a). The Sonora Desert Ecosystem Partnership, between Mexico and the USA, has a common conservation vision and integrated implementation strategies to address cross-border conservation of this ecosystem, which includes tree species (Cornelius and Yruretagoyena, 1998).

1.3.3.4 Forest-associated plant species

There are a large number of diverse plant and forest species in North America, and the number of different species increases with decreasing latitude of the region. In Canada, there are approximately 5,111 vascular plant species in forested and non-forested areas, whereas in the USA, there are approximately 19,518 forest associated vascular plant species (Table 1). In Mexico, there are between 20,000–50,000 species, which includes forest and non-forest associated species (Table 1). Canada and the USA have approximately 126 and 865 tree species respectively, and Mexico has 4,257 forest species. It should be noted that the 2005 Global Forest Resources Assessment (FAO, 2005) identified that North America had 2,400 native forest tree species, of which 180 are in Canada, 1,051 in the USA, and 1,130 in Mexico (FAO, 2005)[5]. This represents approximately 2% of the global tree species richness (WWF-UK, 2004). The difference in the 2013 and 2005 number of Canadian tree species is mostly likely related to the definition of a tree species (i.e., in 2013, a tree was considered to be ≥10 m).

1.4. State of policies, institutions, and human capacity building in the region

Canada, Mexico, and the USA are all making continuous efforts to achieve sustainable forest management and conservation. In North America, there are no national programs for FGRs, however,

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[5] Number of forest tree species identified per country may vary due to differences in the definition of "tree" used in each case.

there are entities that guide and provide leadership on national issues related to FGR. In Canada, the Conservation of Forest Genetic Resources (CON**FOR**GEN), and in Mexico, The Program for the Management of Forest Genetic Resources provide varying degrees of national-level guidance for FGR (FAO, 2013a,c). Federal lands in the USA are mandated to be "sustainable". In all three countries, there has been a rise in certified sustainable products for marketing reasons.

In Canada and Mexico, there are national programs that provide a source of information for national reporting purposes. These are CON**FOR**GEN in Canada (FAO, 2013a) and Comision Nacional Forestal (CONAFOR) in Mexico (FAO, 2013c). The USDA Forest Service has a role in reporting on and supporting gene conservation programs (FAO, 2013b) and works with federal and non-federal partners through the Plant Conservation Alliance (http://www.nps.gov/plants/). In addition, cooperative tree improvement programs exist, including the Central America and Mexico Coniferous Resources Cooperative (CAMCORE), hosted by North Carolina State University, Raleigh, USA, which deals with the exploration, collection, exchange, testing, improvement, and conservation of conifers and some broadleaved species originating in Mexico and Central America (FAO, 2013b).

All three countries have numerous institutional-level capacities in FGR, including those conducted through universities, colleges, research institutes, government departments, industry, and non-governmental organizations. Training is provided through multiple means, including undergraduate and postgraduate courses that include subjects related to FGRs. Canada and Mexico have identified the need to enhance training and education in their countries, but the number of universities with forest genetics programs has decreased in the USA.

PART 2 - Regional needs and priorities

2.1 Improve FGR knowledge

Improving FGR knowledge generation, gathering, and dissemination is important for evaluating ecosystem health and preventing the loss of genetic resources (Table 7). Examples of the needs and priorities identified by countries include research in developing molecular methods to accurately quantify and assess interspecific and intraspecific variation, and determine the number and range of populations, especially for priority species (Table 8). Species-specific genetic diversity assessments would enable the evaluation of diversity within and among species, the determination of their adaptive potential to various stressors, and their level of resistance to high impact stressors. Another identified priority was the management of information regarding the status of species in order to assist in the decision making related to FGR conservation and management (Tables 6, 8). This would involve rapid information exchange to quickly identify threats and mitigation protocols to respond to or prevent a disaster.

2.2 Conservation

For *in situ* conservation, similarities between countries included the creation of new protected areas (PAs) and supporting the development and maintenance of these PAs (FAO, 2013a,c)(Tables 7, 8). Another common need was providing information and/or technical assistance to multiple stakeholders to further support sustainable forest management, cultural awareness and conservation. For Canada, ensuring that the genetic diversity of the most threatened or endangered at-risk species and unique populations (e.g., special ecotypes and pest-resistant population) is conserved was identified as a priority (FAO, 2013a). For Mexico, favoring natural regeneration over artificial regeneration to ensure recovery of native species and strengthening research in multiple biological and ecological fields was mentioned as a priority (FAO, 2013c).

Canadian *ex situ* needs included the prioritization of species (endangered, threatened, special concern, and at risk from alien invasive species), as well as gap analyses to analyze and optimize genetic sampling. Increasing the priority of *ex situ* conservation was also identified due to potential negative impact resulting from climate change and the possibility of their use in assisted migration programs to best position species to adapt to a changing climate (FAO, 2013a). Mexican *ex situ* conservation priorities included the development and implementation of the proposed Mexican Standard for germplasm to ensure for the quality of forest germplasm used for reforestation activities (FAO, 2013c). This approach would allow the classification and identification of the sources of germplasm and enable reforestation efforts to use plants from the same sub-provinces as existed previously in a given area. Other needs included the delivery of training workshops for the establishment and certification of production units and storage facilities in accordance with the Mexican Standard, as well as support for the maintenance and management of production units, banks, and storage facilities (Table 8).

2.3 Sustainable forest resource management and use

Sustainable forest management (SMF) aims to provide cultural, economic, environmental, and social opportunities for both present and future generations. When genetic resources are used in a sustainable manner, they will contribute to economic diversification and income generation and can assist with poverty alleviation in rural economies through agroforestry, fuelwood management, the provision and use of NTFPs, and commercial forestry. The adoption of sustainable forestry practices can enhance food production and food security because some FGRs are important food sources (mast crops such as nut crops, fruit trees, etc.), produce wood products for sale or consumption, and improve ecosystem stability, thereby enhancing sustainability. As noted by the USA, “genetic diversity must be preserved for current and future use, but simple preservation is not enough. If germplasm is not readily available for use, resources expended to preserve it will be wasted” (FAO, 2013b).

For Mexico, extreme poverty, environmental degradation, and loss of natural resources are mentioned as priorities that require immediate attention. The preservation and sustainable use of natural resources depends in large part on addressing all of these issues (FAO, 2013c). The needs and priorities for SFM are many and tend to be extremely important for rural populations and communities that depend on these resources for multiple reasons, and that manage forests for maximum benefit as part of their livelihood strategies.

2.4 Improvement of genetic material

Genetic improvement of FGRs in North America is underway in Canada and the USA, and programs are emerging in Mexico (FAO, 2013a,b,c). The main objectives for improvement include increased growth rates followed by wood quality and pest resistance, and most of the species subjected to genetic improvement are used primarily for timber production. Other secondary uses for species undergoing tree improvement include pulpwood production and NTFPs such as Christmas trees, essential oils, food crops, and medicines.

In Canada, genetic improvement programs exist for 38 species and two genera (*Larix* and *Populus*), including hybrids. In these programs, 10 species and two genera (*Larix* and *Populus*) with hybrids are not native to Canada (FAO, 2013a). In the USA, there are at least 150 public or cooperative programs representing over 70 species, and these species are mostly fast-growing conifers, high-value hardwoods, or fast-growing hardwoods such as poplar (FAO, 2013b). Apart from *Eucalyptus*, most tree improvement programs in the USA deal with native species. In Mexico, 21 programs exist for 14 species, for which 11 are native and three are exotic (FAO, 2013c).

The extent of genetic improvement of species varies between countries in the region and is more advanced in Canada and the USA because they have material at advanced levels of genetic improvement for multiple species and are now able to use the genetic gains acquired through these programs for reforestation purposes (FAO, 2013a,b). In Mexico, advanced levels of improvement are emerging, and advanced material (second generation and higher) is available for a few species (*Pinus greggii, Pinus patula*), but most of this material is currently at the research level, and production is not high enough for use in commercial forest plantations (FAO, 2013c).

Programs in all three countries involve different stakeholders that cooperate with each other, such as government, private companies/industry, and universities.

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Tables for the North American regional synthesis on the State of the World Forest Genetic Resources:

Please note that we are using the definition of priority species that the FAO has provided in the Guidelines for preparing the Country reports document. They are species for which each country has identified that are either, economic, social or of cultural importance or the species is threatened or invasive (priority for removal). We have included all priority species for each country.

Table 1: Regional summary table of general information on forest and plant species in North America.

Countries	Total country area (1,000ha)	Natural forest area (1,000ha)	Planted forest area (1,000ha)	Total forest area (1,000ha)	% of country land area	Type forest(s)	Number of plant species	Number of priority forest species
Canada	998,467[1]	NA[2]	NA[2]	397,262[3]	39.8%	**Canadian Forest Ecosystem Classification System**. Total of 10 forest types: Boreal, Great Lakes-St-Lawrence, Acadian, Carolinian, SubAlpine, Columbia, Montane, Coastal, Tundra, Grasslands. [4]	• 5,111 known vascular plant species[5] • 126 tree species[4]	64 species, varieties or hybrids[4]
Mexico	197,255[6]	NA	NA	144,529[7]	73.3%	**Miranda and Hernandez (1963)[8] classification system of vegetation types:** Total of 13 vegetation types –	• Between 20,000-50,000 vascular plant	Total of 294 species; CONABIO recognizes 240 species (233 native, 7 exotics) for ecological

						Coniferous forest, Oak forest, Cloud forest, Cultivated forest, Evergreen forest, Semi-evergreen seasonal forest, Evergreen seasonal forest, Deciduous lowland forest, Hydrophilic vegetation, Other vegetation types, Desert scrub, Grassland, Induced vegetation[9]	species (26,000 according to Mexican Institute of Ecology)[10] • 4,257 forest species[7]	restoration and reforestation, and considers 85 species to be of economic, ecologic and social importance.[7]
United States	963,203[11]	267,539[12]	36,483[12]	304,022[11]	31.6%	**National Forest classification of federal lands in the United States (Forest Cover Types of the US and Canada, Society of American Foresters)**. Total of 27 forest types: **Western Forests (11)** (Douglas-fir, Hemlock-Sitka spruce, Ponderosa pine, Western white pine, Lodgepole pine, Larch, Fir-spruce, Redwood, Chaparral, Pinion-juniper, Western hardwoods); **Eastern Forests (10)** (White-red-jack pine, Spruce-fir, Longleaf-slash pine, Loblolly-shortleaf-pine, Oak-pine, Oak-hickory, Oak-gum-cypress, Elm-ash-cottonwood, Maple-beech-birch, Aspen-birch); **Alaska Forests (3)** (Spruce-birch, Fir-spruce, Hemlock-Sitka spruce); **Puerto Rico Forests (1)** (Evergreen broadleaf forest); **Hawaii Forests (2)** (Native forest, Mixed forest)[11]	• 19,518 forest associated vascular plant species[13] • 865 forest tree species.[14]	Total of 122 species: 22 threatened or endangered species/ conservation.[15] 101 species important for regeneration.

NA, data not available.

[1] Global Forest Resources Assessment 2010. Canadian report for the FAO. Data for natural forest area was determined by summing the totals for primary forest and naturally regenerated forest.
[2] Data should become available in the next Canadian Forest Resource Assessment Report to be submitted to the FAO.
[3] The State of Canada's Forests-Annual Report 2012.
[4] Report on the State of Canada's Forest Genetics Resources (April 2012)(p.11)
[5] http://www.wildspecies.ca/wildspecies2010/results-vascular.cfm?lang=e (accessed June 2013)
[6] Global Forest Resources Assessment 2010. Mexican report for the FAO.
[7] Forest Genetics Resources Situation in Mexico-Final report on project TCP/MEX/3301/MEX (4) (Mexico 2012) (p.22)
[8] Miranda F. and Hernández-X. E. 1963. Los tipos de vegetación en México y su clasificación. *Boletín de la Sociedad Botánica de México* **28**:29-179.
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[10] http://www.vivanatura.org/Plants.html (accessed June 2013)
[11] Global Forest Resources Assessment 2010-Country Report-United States of America.
[12] Country Report on the State of Forest Genetic Resources-United States of America (June 2012)-(p.11)
[13] Country Report on the State of Forest Genetic Resources-United States of America (June 2012)(p.22).
[14] Little, E.C. 1978. Checklist of US trees (native and naturalized). USDA Agriculture Handbook No. 541.
[15] The number of species presented in this table is not the same as those identified in the Country Report on the State of Forest Genetic Resources-United States of America. This is due to Hawaiian species being included in the US country report but not in the tables for the regional report.

Table 2: List of priority species and their main use in North America.

Species	Plant type: Tree (T) Shrub (S) Cactus (C) [1]	Species natural range: Canada (C) Mexico (M) United States of America (US)[1]	Canada[2]	Mexico[3]	United States[4]
Abies × shastensis	T[5]	US			X[El]
Abies amabilis	T[5]	C,US	X[En]		X[El]
Abies balsamea	T[5]	C,US	X[En,El]		X[El]
Abies concolor	T[5]	US,M			X[En,El]
Abies fraseri	T[5,6]	US			X[En,El]
Abies grandis	T[5]	C,US	X[En]		X[En,El]

Abies lasiocarpa	T[5]	C,US	X[En]		X[En,El]
Abies magnifica	T[5,6]	US			X[El]
Abies procera	T[5]	US	X[En]		X[El]
Abies religiosa	T[7]	M		X[En,El,S]	
Acer macrophyllum	T[5]	C,US	X[En]		
Acer rubrum	T[5]	C,US	X[En,El]		X[En]
Acer saccharum	T[5]	C,US	X[En,El]		X[En]
Alnus rubra	T[5]	C,US	X[En]		
Avicennia germinans	T,S[7,6]	M,US		X[En,El,S]	
Banara vanderbiltii	T,S[6]	US-Puerto Rico			X[S]
Betula alleghaniensis	T[5]	C,US	X[En,El]		X[El]
Betula neoalaskana	T,S[6]	C,US	X[En,El]		
Betula papyrifera	T[5]	C,US	X[En,El]		
Betula uber	T[6]	US			X[S]
Brosimum alicastrum	T[8]	M		X[En,El,S]	
Bursera simaruba	T,S[6]	US		X[En,El,S]	
Buxus vahlii	T,S[6]	US-Puerto Rico			X[S]
Callitropsis nootkatensis	T[5]	C,US	X[En]		
Calocedrus decurrens	T[6,8]	M,US			X[El]
Calyptranthes thomasiana	T,S[6]	US-Puerto Rico			X[S]
Calyptronoma rivalis	T[6]	US-Puerto Rico			X[S]
Carya cordiformis	T[5]	C,US	X[El]		
Carya illinoinensis	T[5,6]	M,US			X[El]
Carya laciniosa	T[6]	C,US			X[El]
Carya ovata	T[5]	C,US	X[El]		X[El]
Castanea dentata	T[6]	C,US			X[El]

Cedrela odorata	T[7,6]	M		X[En,El,S]	
Ceiba pentandra	T[8]	M		X[En,El]	
Celtis occidentalis	T,S[6]	C,US	X[El]		
Cercocarpus traskiae	T,S[6]	US			X[S]
Chamaecyparis lawsoniana	T[6]	US			X[El]
Chamaecyparis thyoides	T[6]	US			X[El]
Cordia dodecandra	T,S[8]	M		X[En,El,S]	
Cornutia obovata	T,S[6]	US-Puerto Rico			X[S]
Crescentia portoricensis	T,S[6]	US-Puerto Rico			X[S]
Cupressus abramsiana	T[6]	US			X[S]
Cupressus goveniana	T,S[6]	US			X[S]
Cupressus nootkatensis	T[6]	C,US			X[S]
Diospyros virginiana	T[6]	US			X[S]
Enterolobium cyclocarpum	T[8]	M		X[En,El,S]	
Fagus grandifolia	T[6]	C,M,US			X[El]
Fraxinus americana	T[5]	C,US	X[En,S]		X[El]
Fraxinus nigra	T[5]	C,US	X[En,El]		X[S]
Fraxinus pennsylvanica	T[5]	C,US	X[El]		X[El]
Fraxinus profunda	T[6]	C,US			X[S]
Fraxinus quadrangulata	T[6]	C,US			X[S]
Fremontodendron mexicanum	T,S[6]	US			X[S]
Gleditsia triacanthos	T,S[6]	C,US			X[El]
Gliricidia sepium	T[8]	M		X[En,El,S]	
Goetzea elegans	T[6]	US-Puerto Rico			X[S]
Gymnocladus dioicus	T[6]	C,US			X[El]
Ilex americana (Ilex opaca)	T,S[6]	US			X[El]

Ilex cookie	T,S[6]	US-Puerto Rico			X[S]
Ilex sintenisii	T,S[6]	US-Puerto Rico			X[S]
Juglans cinerea	T[5]	C,US	X[El]		X[El]
Juglans jamaicensis	T[6]	US-Puerto Rico			X[S]
Juglans nigra	T[6]	C,US			X[En,El]
Larix laricina	T[5]	C,US	X[En,El]		X[El]
Larix lyallii	T[5]	C,US	X[El]		
Larix occidentalis	T[5]	C,US	X[En,El]		X[El]
Larix spp.	T[5]	NA	X[El]		
Leucaena leucocephala	T,S[6,8]	M,US		X[En,El,S]	
Lindera melissifolia	T,S[6]	US			X[S]
Liquidambar styraciflua	T[5,6]	M,US			X[En,El]
Liriodendron tulipifera	T[6,8]	C,US			X[En,El]
Manilkara zapota	T[8]	M		X[En,El,S]	
Ostrya virginiana	T,S[6,8]	C,M,US	X[El]		
Picea abies	T[6]	C,US	X[En]		
Picea breweriana	T[6]	US			X[El]
Picea engelmannii	T[7]	C,US	X[En]		X[En,El]
Picea glauca	T[5]	C,US	X[En,El]		X[El]
Picea glauca x engelmannii	T[5]	C,US	X[En]		
Picea mariana	T[5]	C,US	X[En,El]		X[El]
Picea pungens	T[6]	C,US			X[El]
Picea rubens	T[5]	C,US	X[En]		
Picea sitchensis	T[5]	C,US	X[En]		
Pilosocereus robinii	C[6]	US			X[S]
Pinus albicaulis	T[5]	C,US	X[El]		X[El]
Pinus aristata	T[6]	US			X[El]

Pinus attenuata	T[6]	US			X[El]
Pinus ayacahuite	T[9]	M		X[En,El,S]	
Pinus balfouriana	T[6]	US			X[El]
Pinus banksiana	T[5]	C,US	X[En,El]		X[En,El]
Pinus cembroides	T,S[9]	M,US		X[En,El,S]	
Pinus chiapensis	T[9]	M		X[En,El,S]	
Pinus contorta	S,T[9]	C,M,US	X[El]		X[En]
Pinus contorta var. *latifolia*	T[9]	C,US	X[En,El]		X[El]
Pinus coulteri	T[6,9]	M,US			X[El]
Pinus devoniana	T[9]	M		X[En,El,S]	
Pinus douglasiana	T[9]	M		X[En,El,S]	
Pinus durangensis	T[9]	M		X[En,El,S]	
Pinus echinata	T[6]	US			X[El]
Pinus elliottii	T[6]	US			X[El]
Pinus engelmannii	T[9]	M,US		X[En,El,S]	
Pinus flexilis	T[9]	C,US	X[El]		X[El]
Pinus greggii	T[9]	M		X[En,El,S]	
Pinus jeffreyi	T[6,9]	M,US			X[El]
Pinus lambertiana	T[6,9]	M,US			X[El]
Pinus longaeva	T[6]	US			X[El]
Pinus maximinoi	T[9]	M		X[En,El,S]	
Pinus montezumae	T[9]	M		X[En,El,S]	
Pinus monticola	T[9]	C,US	X[En]		X[El]
Pinus oaxacana	T[9]	M		X[En,El,S]	
Pinus oocarpa	T[9]	M		X[En,El,S]	
Pinus palustris	T[6]	US			X[El]
Pinus patula	T[9]	M		X[En,El,S]	
Pinus ponderosa	T[9]	C,M,US	X[En]		X[En]

Pinus pseudostrobus	T[9]	M		X[En,El,S]	
Pinus pungens	T[6]	US			X[El]
Pinus resinosa	T[9]	C,US	X[En,El]		X[El]
Pinus rigida	T[5]	C,US	X[En,El]		X[El]
Pinus sabiniana	T[6]	US			X[El]
Pinus serotina	T[6]	US			X[El]
Pinus strobiformis	T[9]	M,US			X[El]
Pinus strobus	T[5]	C,US	X[En,El]		X[En,El]
Pinus sylvestris	T[5]	C,US	X[El,S]		
Pinus taeda	T[5,6]	US			X[En]
Pinus teocote	T[9]	M		X[En,El,S]	
Pinus virginiana	T[6]	C,US			X[El]
Platanus occidentalis	T[5,6]	C,M,US			X[El]
Populus balsamifera	T[5]	C,US	X[En,El]		
Populus balsamifera x trichocarpa	T[5]	C,US	X[En]		X[El]
Populus deltoides	T[5]	C,US	X[En,El]		
Populus grandidentata	T[5]	C,US	X[En]		
Populus native hybrids	T[5]	C,US	X[El]		
Populus non-native hybrids	T[5]	C,US	X[En]		
Populus tremuloides	T[5]	C,US	X[En]		X[En]
Prosopis juliflora	S,T[8]	M		X[En,El,S]	
Prunus angustifolia	T[6]	US			X[El]
Prunus serotina	T[5,6]	C,M,US			X[En]
Pseudotsuga menziesii	T[5]	C,M,US	X[En]	X[En,El,S]	X[En]
Pseudotsuga macrocarpa	T[6]	US			X[El]
Quercus bicolour	T[5]	C,US	X[El]		X[El]
Quercus acutissima	T[6]	US			X[El]
Quercus alba	T[5]	C,US	X[El]		X[En]

Quercus falcata	T[6]	US			X[El]
Quercus falcata paegodifolia	T[6]	US			X[El]
Quercus garryana	S,T[5]	C,US	X[El]		
Quercus laurina	T[8]	M		X[El,S]	
Quercus lyrata	T[6]	US			X[El]
Quercus macrocarpa	T[5]	C,US	X[En,El]		X[El]
Quercus macrophylla	T[10]	M		X[En,El,S]	
Quercus michauxii	T[6]	US			X[El]
Quercus muehlenbergii	T[5,6]	C,M,US			X[El]
Quercus nigra	T[6]	US			X[El]
Quercus nuttalli	T[6]	US			X[El]
Quercus pagoda	T[6]	US			X[El]
Quercus phellos	T[6]	US			X[El]
Quercus prinus	T[5,6]	C,US			X[En,El]
Quercus rubra	T[5]	C,US	X[En,El,S]		X[En]
Quercus rugosa	T[8]	M,US		X[En,El,S]	
Quercus shumardii	T[6]	C,US			X[El]
Quercus stellata	T[6]	US			X[El]
Quercus texana	T[6]	US			X[El]
Quercus velutina	T[6]	C,US			X[en]
Quercus virginiana	T[5]	M,US		X[En,El,S]	
Rhizophora mangle	T[7,8]	M,US		X[En,El,S]	
Robinia pseudoacacia	T[6]	C,US			X[El]
Salix spp.	T,S[5]	NA	X[El]		
Sequoiadendron giganteum	T[6]	US			X[El]
Simarouba glauca	T[8]	M,US		X[En,El,S]	
Solanum drymophilum	T,S[6]	US-Puerto Rico			X[S]
Stahlia monosperma	T[6]	US-Puerto Rico			X[S]

Swietenia macrophylla	T[7,8]	M		X[En,El]	
Tabebuia donnell-smithii	T[8]	M		X[En,El]	
Tabebuia rosea	T[8]	M		X[En,El,S]	
Taxodium distichum	T[6]	US			X[El]
Thuja occidentalis	T[5]	C,US	X[En,El]		X[El]
Thuja plicata	T[5]	C,US	X[En]		
Tilia americana	T[5]	C,US	X[El]		
Torreya taxifolia	T[6]	US			X[S]
Tsuga canadensis	T[5]	C,US	X[En]		X[En]
Tsuga caroliniana	T[6]	US			X[El]
Tsuga heterophylla	T[5]	C,US	X[En]		X[En]
Tsuga mertensiana	T[6]	C,US			X[El]
Ulmus americana	T[5]	C,US	X[El]		X[El]
Ulmus rubra	T[5]	C,US	X[El]		
Zanthoxylum thomasianum	T,S[6]	US-Puerto Rico			X[S]

Countries identified priority species in their respective country reports. An X denotes that this species was a priority for a country and the superscripts En (Economical), El (Ecological), S (Social) pertain to the type of activity identified in the country reports. A blank cell indicates that this species was not identified as a priority for a country. For species native to the continental US, *US* abbreviation is used and for species native to Puerto Rico, *US-Puerto Rico* abbreviation is used.

NA, Data not available at the genus level.

[1] Note: The references that are part of the column "Plant type" were used to determine information entered into the "Plant type" as well as the "Species natural range" columns.

[2] Report on the State of Canada's Forest Genetics Resources (April 2012)-Table 1.6 (p.34-36); Commercial purposes from Table 1.6 were entered as Economical (En), Ecological included Carbon sequestration, Ecosystem preservation and Species conservation (El) and Social (S) included Urban Forestry and Historical value.

[3] Forest Genetics Resources Situation in Mexico-Final report on project TCP/MEX/3301/MEX (4) (Mexico 2012)- Table 1.7,1.8 (p.10-11)

[4] Country Report on the state of Forest Genetic Resources- United States of America (June 2012)

[5] http://www.na.fs.fed.us/spfo/pubs/silvics_manual/table_of_contents.htm searches were done using species name (accessed June 2013)

[6] http://plants.usda.gov/java/ searches were done using species name (accessed June 2013)

[7] http://www.iucnredlist.org/search searches were done using species name (accessed June 2013)
[8] http://en.wikipedia.org/wiki/Main_Page searches were done using species name (accessed June 2013)
[9] The Gymnosperm database: http://www.conifers.org/index.php (accessed August 2013)
[10] Elsevier's Dictionary of Trees: Volume 1: North America, Volume 1 (accessed June 2013)

Table 3: North American priority species subject to selection, evaluation and improvement activities

Priority species	**Breeding and domestication**					**Quality of seed supplied for reforestation**			**Countries involved in this research work**
	Species provenance tests	Species progeny tests	Reproductive biology - Seed Classification: Orthodox (O), possibly Orthodox (O?), Recalcitrant (R), possibly Recalcitrant(R?), Intermediate (I), possibly Intermediate (I?)	Molecular analysis: DNA based (D) Non-DNA based (N) or X (done but no specifics)	Propagation (vegetative & sexual)	Identified seed sources[1]	Selected seed stands[2]	Seed orchard	
Abies amabilis	X[3]		O[4]						Canada[3]
Abies balsamea	X[3,5]	X[5]	O[4]		V[6]			X[5,7]	US[5] Canada[3,6,7]
Abies concolor		X[5]	O[8]					X[5]	US[5]
Abies fraseri		X[5]	O[8]					X[5]	US[5]

Abies grandis	X[3]		O[4]						Canada[3]
Abies lasiocarpa	X[3,5]		O[4]						US[5] Canada[3]
Abies procera	X[3]		O[9]						Canada[3]
Abies religiosa			O[9]	X[10]					Mexico[10]
Acacia koa		X[5]	O[9]					X[5]	US[5]
Acer macrophyllum	X[3]	X[11]	O[9]						Canada[3,11]
Acer rubrum			R-I-O[9]						
Acer saccharum	X[5]		R[9]	N[12]				X[5]	US[5] Canada[12]
Alnus rubra	X[3]	X[11]	O[8]	N[12]	V[6]			X[7]	Canada[3,6,7,11,12]
Avicennia germinans			R? [9]						
Betula alleghaniensis	X[3,5]		O[9]						US[5] Canada[3]
Betula neoalaskana			O[9]						
Betula papyrifera	X[5]		O[9]						US[5]
Brosimum alicastrum			NA						
Bursera simaruba			NA						
Callitropsis nootkatensis	X[3]	X[11]	O[9]					X[7]	Canada[3,7,11]
Carya cordiformis			O[9]						

Carya illinoiensis			O[9]					X[5]	US[5]
Carya ovata		X[5]	O[9]						US[5]
Castanea dentata		X[5]	R[9]	D[5]	V[5]			X[5]	US[5]
Cedrela odorata			R[9]	X[10]	V[13]			X[14]	Mexico[10,13,14]
Ceiba pentandra			O?[9]						
Celtis occidentalis			O[4]						
Chamaecyparis lawsoniana		X[5]	O[9]					X[5]	US[5]
Chamaecyparis thyoides		X[5]	O[9]						US[5]
Cordia dodecandra			NA						
Diospyros virginiana		X[5]	U[9]			X[5]			US[5]
Enterolobium cyclocarpum			O[9]						
Fagus grandifolia		X[5]	O?[9]					X[5]	
Fraxinus americana	X[3,5]	X[5,11]	O[4]		V/S[6]			X[5,7]	US[5] Canada[3,6,7,11]
Fraxinus nigra			O[4]						
Fraxinus pennsylvanica	X[3]	X[5]	O[4]					X[5]	US[5] Canada[3]
Gliricidia sepium			O[9]						

Juglans cinerea		X[5,11]	O[4]?	D[12], N[12]				X[5]	US[5] Canada[11,12]
Juglans nigra		X[5]	R[4]			X[5]		X[5]	US[5]
Larix decidua		X[5]	O[9]					X[5]	US[5]
Larix kaempferi		X[5]	O[9]					X[5]	US[5]
Larix laricina	X[3,5]	X[5,11]	O[4]	N[12]	V/S[6]			X[5,7]	US[5] Canada[3,6,7,11,12]
Larix lyallii			O[4]						
Larix occidentalis	X[3,5]	X[5,11]	O[4]	D[12], N[12]	V[6]			X[5,7]	US[5] Canada[3,6,7,11,12]
Larix spp.	X[3]		O[9]						Canada[3]
Leucaena leucocephala			NA						
Liquidambar styraciflua		X[5]	O[9]					X[5]	US[5]
Liriodendron tulipifera		X[5]	O?[4]					X[5]	US[5]
Manilkara zapota			NA						
Ostrya virginiana			O[9]						
Picea abies	X[3]	X[5,11]	O[9]		V/S[6]			X[5,7]	US[5] Canada[3,6,7,11]
Picea engelmannii	X[5]		O[4]	N[5]					US[5]
Picea glauca	X[3,5]	X[5,11]	O[4]	D[12],N[12]	V/S[6]			X[5,7]	US[5] Canada[3,6,7,11,12]
Picea glauca x engelmannii	X[3]	X[11]	O[9]		V[6]			X[7]	Canada[3,6,7,11]

Picea mariana	X[3,5]	X[5,11]	O[4]	D[12]	V/S[6]			X[5,7]	US[5] Canada[3,6,7,11,12]
Picea rubens	X[3,5]	X[11]	O[4]	N[12]	V[6]			X[7]	US[5] Canada[3,6,7,11,12]
Picea sitchensis	X[3,5]	X[11]	O[4]	D[12],N[12]	V[6]			X[7]	US[5] Canada[3,6,7,11,12]
Pinus albicaulis	X[5]	X[5]	O[4]	N[12]				X[5]	US[5] Canada[12]
Pinus ayacahuite				X[10]					Mexico[10]
Pinus banksiana	X[3,5]	X[5,11]	O[9]	D[12],N[12]	V/S[6]			X[5,7]	US[5] Canada[3,6,7,11,12]
Pinus cembroides			O[9]						
Pinus chiapensis			O[9]						
Pinus contorta	X[5]	X[5]	O[4]					X[5]	US[5]
Pinus contorta var. *latifolia*	X[3]	X[11]	O[4]	D[12],N[12]	V/S[6]			X[7]	Canada[3,6,7,11,12]
Pinus devoniana			O[9]						
Pinus douglasiana			O[9]		S[13]			X[14]	Mexico[13,14]
Pinus durangensis			O[9]						
Pinus echinata		X[5]	O[9]					X[5]	US[5]

Pinus elliottii		X[5]	O[9]					X[5]	US[5]
Pinus engelmannii			O[9]						
Pinus flexilis	X[5]		O[4]						US[5]
Pinus greggii			O[9]	X[10]	S[13]			X[13]	Mexico[10,13,14]
Pinus lambertiana		X[5]	O[9]					X[5]	US[5]
Pinus maximinoi			O[9]						
Pinus montezumae			O[9]	X[10]					Mexico[10]
Pinus monticola	X[3,5]	X[5,11]	O[4]	D[12]	V/S[6]			X[5,7]	US[5] Canada[3,6,7,11,12]
Pinus oaxacana			O[4]						
Pinus oocarpa			O[9]	X[10]	S[13]			X[14]	Mexico[10,13,14]
Pinus palustris	X[5]	X[5]	O[9]					X[5]	US[5]
Pinus patula			O[9]	X[10]	V/S[13]			X[14]	Mexico[10,13,14]
Pinus ponderosa	X[3,5]	X[5]	O[4]		V/S[6]			X[5,7]	US[5] Canada[3,6,7]
Pinus pseudostrobus			O[9]	X[10]	V/S[13]			X[14]	Mexico[10,13,14]
Pinus resinosa	X[3,5]	X[5]	O[4]	D[12],N[12]	S[6]			X[5,7]	US[5] Canada[3,6,7,12]
Pinus rigida	X[3,5]		O[4]	N[12]					US[5]

									Canada[3,12]
Pinus serotina		X[5]	O[9]					X[5]	US[5]
Pinus strobus	X[3,5]	X[5,11]	O[4]	D[12],N[12]	V[6]			X[5,7]	US[5] Canada[3,6,7,11,12]
Pinus sylvestris	X[3]	X[5]	O[9]		S[6]			X[5,7]	US[5] Canada[3,6,7]
Pinus taeda	X[5]	X[5]	O[9]	D[5]				X[5]	US[5]
Pinus teocote			O[9]						
Pinus virginiana		X[5]	O[9]					X[5]	US[5]
Platanus occidentalis		X[5]	O[9]					X[5]	US[5]
Populus balsamifera	X[3,5]	X[11]	O[4]	D[12],N[12]	V[6]				US[5] Canada[3,6,11,12]
Populus balsamifera x trichocarpa	X[3]		O[9]						Canada[3]
Populus deltoides	X[5]	X[5,11]	O[4]	D[12]				X[5]	US[5] Canada[11,12]
Populus grandidentata	X[5]		O[4]						US[5]
Populus native hybrids		X[5]	O[9]		V[6]				US[5] Canada[6]
Populus non-native hybrids			I – O[9]		V[6]				Canada[6]
Populus tremuloides	X[3,5]	X[11]	I[9]	D[12],N[12]	V[6]				US[5] Canada[3,6,11,12]

Prosopis juliflora			O[9]						
Prunus angustifolia		X[5]	NA			X[5]			US[5]
Prunus serotina			O[9]					X[5]	US[5]
Pseudotsuga menziesii	X[3,5]	X[5,11]	O[4]	N[12], X[10]	V/S[6]			X[5,7]	US[5] Canada[3,6,7,11,12] Mexico[10]
Quercua accutissimo		X[5]	R[9]					X[5]	US[5]
Quercus alba		X[5]	R[4]					X[5]	US[5]
Quercus bicolour		X[5]	R[4]					X[5]	US[5]
Quercus falcata		X[5]	R[4]			X[5]			US[5]
Quercus garryana			R[4]	N[12]					Canada[12]
Quercus laurina			R[4]						
Quercus lyrata		X[5]	R[4]						US[5]
Quercus macrocarpa		X[5]	R[4]					X[5]	US[5]
Quercus macrophylla			R[4]						
Quercus michauxii		X[5]	R[4]					X[5]	US[5]
Quercus nigra		X[5]	R[4]					X[5]	US[5]
Quercus nuttalli			R[4]			X[5]			US[5]
Quercus pagoda		X[5]	R[4]					X[5]	US[5]

Quercus phellos			R[4]					X[5]	US[5]
Quercus prinus		X[5]	R[4]						US[5]
Quercus rubra	X[3,5]	X[5,11]	R[4]		V[6]			X[5,7]	US[5] Canada[3,6,7,11]
Quercus rugosa			R[9]						
Quercus shumardii		X[5]	R[4]						US[5]
Quercus stellate		X[5]	R[4]						US[5]
Quercus texana		X[5]	R[4]					X[5]	US[5]
Quercus velutina		X[5]	R[4]						US[5]
Quercus virginiana			R[9]						
Rhizophora mangle			R?[9]						
Robinia pseudoacacia		X[5]	O[9]					X[5]	US[5]
Salix spp.			I-O[9]						
Simarouba glauca			NA						
Swietenia macrophylla			I?[9]						
Tabebuia donnell-smithii			NA						
Tabebuia rosea			O[9]						
Taxodium disticum		X[5]	O[9]					X[5]	US[5]
Taxodium disticum var.		X[5]	O[9]						US[5]

ascendens									
Thuja occidentalis	X[5]	X[5]	O[4]		S[6]			X[5,7]	US[5] Canada[6,7]
Thuja plicata	X[3]	X[11]	O[4]	D[12],N[12]	V[6]			X[7]	Canada[3,6,7,11,12]
Tilia americana			O[4]						
Tsuga canadensis	X[3,5]	X[5]	O[4]						US[5] Canada[3]
Tsuga heterophylla	X[3]	X[5,11]	O[4]		V[6]			X[5,7]	US[5] Canada[3,6,7,11]
Ulmus americana		X[5]	O[4]					X[5]	US[5]
Ulmus rubra			O[4]						

An empty cell means that there is no activity for this species.
NA, data not available.

[1] Seed collected from natural stands. Data available but not reported on in Canada.
[2] Seed collected from selected natural stands.
[3] Report on the State of Canada's Forest Genetics Resources -Table 4.2 (p111-112)
[4] Unpublished CAnadian Forest Genetic Resources Information System (CAFGRIS) data
[5] Country Report on the State of Forest Genetic Resources in the United States of America.
[6] Report on the State of Canada's Forest Genetics Resources -Table 4.4 and table 4.5 (p.114-115); This column was filled based on the type of material used for breeding. If material deployed were seedlings, then "S" was inserted in column. If material deployed was from clones, then "V" was inserted. If species had both, seedlings and clones then "V/S" was inserted. Other species included (not part of Table 4.5) but part of Table 4.4 that were used for reforestation purposes were labeled as "V" since they were from clonal material.
[7] Report on the State of Canada's Forest Genetics Resources -Table 4.5 (p114-115)
[8] The Woody Plant Seed Manual. United States Department of Agriculture, Forest Service. Agricultural Handbook 727. July 2008.
[9] Compendium of Information on Seed Storage behaviour, Volume I and II, Hong, Linington and Ellis. 1998. Royal Botanical Gardens, Kew. Under the column *Reproductive Biology*, when there is more than one letter to denote seed storage behaviour this indicates that the species may exhibit seed storage variability. When the letter is followed by a question mark, this indicates uncertainly in the designated storage behaviour.

[10] Forest Genetics Resources Situation in Mexico-Final report on project TCP/MEX/3301/MEX (4) -Table 1.2 (p.4-6)
[11] Report on the State of Canada's Forest Genetics Resources - Table 4.3 (p112-113)
[12] Report on the State of Canada's Forest Genetics Resources -Table 1.5 (p26-30)
[13] Forest Genetics Resources Situation in Mexico-Final report on project TCP/MEX/3301/MEX (4) -Table 4.2/4.3 (p.66-67); This column was filled based on the type of material used for breeding. If material deployed was from sexual reproduction (Table 4.2, p.66), then "S" was inserted in column. If material deployed was from asexual reproduction (Table 4.3, p.67), then "V" was inserted. If species had both, then "V/S" was inserted. As mentioned in p.67, "these orchards are based in research and in their current conditions are still unable to intensively produce genetically improved seed for use in commercial forest plantations".
[14] Forest Genetics Resources Situation in Mexico-Final report on project TCP/MEX/3301/MEX (4) -Table 4.2/4.3 (p.66-67)

Table 4: Species with official risk designation requiring high priority[a] at regional level

Species (official risk designation)	Plant type Tree (T) Shrub (S) Herbaceous (H) Cactus (C)[1]	Species natural range Canada (C) Mexico (M) United States (US)[1,2]	Country where species is identified with an official risk designation[3,4,5]	Exploration collection[b]		Evaluation[b]		Conservation[b]		Use and improvement[b]	
				a	b	c	d	e	f	g	h
Acer negundo	T[6]	C,M,US	Mexico								
Agave lechuguilla	S[7]	M,US	Mexico								
Avicennia germinans	T[8]	US	Mexico								
Banara vanderbiltii	S[7,8]	US-Puerto Rico	US								
Betula uber	T[8]	US	US								
Betula lenta	T[6]	C,US	Canada	*[9]	2[9]	1,2[9]		1[9]	2[9]	2[9]	
Buxus vahlii	S[8,10]	US-Puerto Rico	US								

Calyptranthes thomasiana	S,T[10]	US-Puerto Rico	US								
Calyptronoma rivalis	S,T[8]	US-Puerto Rico	US								
Castanea dentate	T[8,10]	C,US	Canada	1,2[11]	*[11]	1[11]	*[11]	2,3[11]	*[11]	*[11]	1[11]
Cedrela odorata	T[6]	M,US-Puerto Rico	Mexico								
Cercocarpus traskiae	S[7,10]	US	US								
Conocarpus erecta	T[8,10]	US	Mexico								
Cornus florida	T[6]	C,M,US	Canada	1[12]	3[12]	1[12]		1,2[12]	3[12]	3[12]	3[12]
Cornutia obovata	S,T[7,10]	US-Puerto Rico	US								
Crescentia portoricensis	S[8]	US-Puerto Rico	US								
Cupressus abramsiana	T[7,8]	US	US								
Cupressus goveniana	S,T[7,10]	US	US								
Cupressus guadalupensis	T[7,10]	M,US	Mexico								
Cupressus lusitanica	T[13]	M	Mexico								
Dalbergia granadillo	T[14]	M	Mexico								
Erythrina coralloides	S,T[10]	M,US	Mexico								
Fagus grandifolia	T[6]	C,M,US	Mexico								
Fraxinus quadrangulata	T[8]	C,US	Canada	2[15]		2[15]		1[15]			

Fremontodendron mexicanum	S[8]	M,US	US								
Goetzea elegans	H[8,10]	US-Puerto Rico	US								
Guaiacum coulteri	H[7,10]	M	Mexico								
Gymnocladus dioicus	T[8]	C,US	Canada	*[16]	*[16]	*[16]	*[16]	*[16]	*[16]		
Ilex cookii	S[8,10]	US-Puerto Rico	US								
Ilex sintenisii	S[8,10]	US-Puerto Rico	US								
Juglans cinerea	T[6]	C, US	Canada	1, 2[17]	1, 2[17]	1, 2[17]	1, 2[17]	1, 2[17]	1, 2[17]	1, 2[17]	1, 2[17]
Juglans jamaicensis	T[8]	US-Puerto Rico	US								
Laguncularia racemosa	T[8,10]	M, US	Mexico								
Licania arborea	S,T[7,10]	M	Mexico								
Lindera melissifolia	S[8]	US	US								
Magnolia acuminata	T[6]	C, US	Canada	1,2[18]		2[18]		2[18]			
Morus rubra	T[6,8]	C,US	Canada	1,2[19]		1[19]	*[19]	1[19]			
Picea chihuahuana	T[6]	M, US	Mexico								
Picea engelmannii	T[10]	C, M, US	Mexico								
Picea martinezii	T[10]	M	Mexico								
Pilosocereus robinii	C[7]	US,M	US								

Pinus albicaulis	T[6]	C, US	Canada	*[20]	*[20]	*[20]	1[20]	*[20]	1[20]	1[20]	1[20]
Pinus caribaea	T[13]	M	Mexico								
Pinus jeffreyi	T[6]	M, US	Mexico								
Pinus lambertiana	T[6]	M, US	Mexico								
Pinus maximartinezii	T[13]	M	Mexico								
Pinus nelsoni	T[13]	M	Mexico								
Pinus pinceana	T[13]	M	Mexico								
Pinus strobus	T[6]	C, M, US	Mexico								
Podocarpus matudai	T?[7,10]	M	Mexico								
Pseudotsuga menziesii	T[6]	C, M, US	Mexico								
Ptelea trifoliata	S, T[7,8]	C, M, US	Canada	2[21]	*[21]	*[21]		2[21]			
Quercus shumardii	T[6]	US	Canada	*[22]		*[22]		*[22]			
Rhizophora mangle	T[7,10]	M, US	Mexico								
Solanum drymophilum	S,T[10]	US-Puerto Rico	US								
Stahlia monosperma	T[8,10]	US-Puerto Rico	US								
Tabebuia chrysantha	T[7]	M	Mexico								
Taxus globosa	S[7,10]	M	Mexico								

Torreya taxifolia	T[6]	US	US								
Zanthoxylum thomasianum	S,T[8]	US-Puerto Rico	US								
Zinowiewia concinna	T[23]	M	Mexico								

In this table, a *1*, denotes a high priority species as indicated by each country; *2*, country has identified the species as requiring prompt action and *3* denotes that action for the species is required but is less urgent than *1* and *2*. The type of action being conducted by each country is: *a*, ecological and biological information (natural distribution, taxonomy, genecology, phenology); *b*, collection of genetic material (seeds, herbarium samples, ...) for assessment; *c*, *in situ* (specifically population study identified); *d*, *ex situ* (specifically provenance and progeny trials identified); *e*, *in situ* (general activities identified); *f, ex situ* (general activities identified); *g*, seed and other reproductive material supply collections and availability; *h*, selection and breeding activities. * denotes that activities have been done or are currently under way and that these activities no not fall within the guidelines identified above (e.g. a-h).
For Canadian species an empty cell means that there is no activity for this species.
For the US and Mexico, data is not presented and for species native to the continental US, US abbreviation is used and for species native to Puerto-Rico, US-Puerto-Rico abbreviation is used.
[a] High Priority species are those that require official risk designation in each country at a federal or national level.
[b] Data not presented for the US and Mexico.

[1] Note: The references that are part of the column "Plant type" were used to determine information entered into the "Plant type" as well as the "Species natural range" columns.
[2] Note: U-PuertoRico indicates that the species is only present in that State. If the species is present in the USA mainland, then U-Puerto-Rico is not used in the column even if the species could be present in that State.
[3] Canadian tree species (11) are based on the Species at Risk Act (SARA) - Table 1.7 (p.38-39) in the Canadian report.
[4] Mexico's tree species include 29 (Annex 4, p.139) of the 117 mentioned (p.16) in the document: Forest Genetics Resources Situation in Mexico-Final report on project TCP/MEX/3301/MEX (4) (Mexico 2012)
[5] US tree species (21) are based on Table 6 (p.19) without taking into account the species from Hawaii (36) in the document: Country Report on the state of Forest Genetic Resources- United States of America (June 2012)
[6] http://www.na.fs.fed.us/spfo/pubs/silvics_manual/table_of_contents.htm searches were done using species name (accessed June 2013)
[7] http://en.wikipedia.org/wiki/Main_Page searches were done using species name (accessed June 2013)
[8] http://plants.usda.gov/java/ searches were done using species name (accessed June 2013)
[9] Zoladeski, C. and K. Hayes. 2013. Recovery Strategy for the Cherry Birch (*Betula lenta*) in Ontario. Ontario Recovery Strategy Series. Prepared for the Ontario Ministry of Natural Resources, Peterborough, Ontario. vi + 12 pp.
[10] http://www.iucnredlist.org/search searches were done using species name (accessed June 2013)

[11] Boland, G.J., J. Ambrose, B. Husband, K.A. Elliott and M.S. Melzer. 2012. Recovery Strategy for the American Chestnut (*Castanea dentata*) in Ontario. Ontario Recovery Strategy Series. Prepared for the Ontario Ministry of Natural Resources, Peterborough, Ontario. vi + 43 pp.
[12] Environment Canada. 2013. Recovery Strategy for the Eastern Flowering Dogwood (*Cornus florida*) in Canada [Proposed]. *Species at Risk Act* Recovery Strategy Series. Environment Canada, Ottawa. 16 pp. + Appendices.
[13] The Gymnosperm database: http://www.conifers.org/index.php (accessed June 2013).
[14] http://www.bgci.org/worldwide/Dalbergia/
[15] http://www.sararegistry.gc.ca/species/speciesDetails_e.cfm?sid=210
[16] http://www.sararegistry.gc.ca/species/speciesDetails_e.cfm?sid=222 (accessed June 2013)
[17] Environment Canada. 2010. Recovery Strategy for the Butternut (*Juglans cinerea*) in Canada [Proposed]. *Species at Risk Act* Recovery Strategy Series. Environment Canada, Ottawa vii + 24 pp.
[18] Ambrose, J. and D. Kirk. 2006. Recovery Strategy for Cucumber Tree (*Magnolia acuminata* L.) in Canada. Prepared for the Ontario Ministry of Natural Resources by the Cucumber Tree Recovery Team, viii + 24pp. + addenda.
[19] Parks Canada Agency. 2010. Recovery Strategy for the Red Mulberry (*Morus rubra*) in Canada [PROPOSED]. *Species at Risk Act* Recovery Strategy Series. Parks Canada Agency. Ottawa, Ontario. vii + 25 pp. + 3 Appendices.
[20] COSEWIC. 2010. COSEWIC assessment and status report on the Whitebark Pine *Pinus albicaulis* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. x + 44 pp. (www.sararegistry.gc.ca/status/status_e.cfm).
[21] Parks Canada Agency. 2011. Recovery Strategy for the Common Hoptree (*Ptelea trifoliata*) in Canada [Proposed]. *Species at Risk Act* Recovery Strategy Series. Parks Canada Agency. Ottawa. vi + 61 pp.
[22] COSEWIC. 1999. COSEWIC assessment and update status report on the shumard oak *Quercus shumardii* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vi + 11 pp. (www.sararegistry.gc.ca/status/status_e.cfm)
[23] http://sweetgum.nybg.org/vh/specimen.php?irn=207188

Table 5: Examples of regional networks and collaboration between countries in North America[1]

Name of networks	Priority area	Species	Institutions	Countries

Regional Networks				
The Food And Agriculture Organization's (FAO) North American Forestry Commission's Forest Genetic Resources Working Group [2,3,4]	*In situ* conservation *Ex situ* conservation Breeding and domestication Information sharing	General	FAO North American Forestry Commission	Canada, Mexico, US
International Model Forest Network (IMFN)	*In situ* conservation Information sharing	General	The IMFN is comprised of all member Model Forests around the world.	Canada, Mexico, US
Subregional Networks				
Boreal Ecosystem–Atmosphere Study (BOREAS)[2]	Information sharing	General	Canadian federal department Natural Resources Canada and the U.S. National Aeronautics and Space Administration (NASA)	Canada, US
Boreal Ecosystem Research and Monitoring Sites (BERMS)[2]	Information sharing	General	Joint federal government–university initiative	Canada, US
North American Plant Collections Consortium (NAPCC)[3]	*Ex situ* conservation Breeding and domestication Information sharing	General	network of botanical gardens and arboreta	Canada, US, Mexico
Central American and Mexioc Coniferous Resources Cooperative (CAMCORE)[4]	*In situ* conservation *Ex situ* conservation Breeding and domestication Information sharing	The program works internationally with four tree genera: Pines, Eucalypts, Gmelina and Teak, and with several threatened coniferous species native to the southern US[5].	North Carolina State University, private forest industry, and government agencies around the world	US, Mexico and other international groups
The University of California Institute for	*In situ* conservation *Ex situ* conservation	*Pinus radiata* var. *binata, Cupressus guadalupensis*	University of California and various research institutions in	Mexico, US

Mexico and the United States (UC Mexus)[4]	Information sharing	and *Quercus tomentella*, endemic taxa from Guadalupe Island, and studies on genetic variation in pine from Baja California[4].	Mexico	
COFAN-U de California[4]	*Ex situ* conservation Information sharing	Three Mexican species of *Picea*, all of which are in danger of extinction, and currently in *Pinus coulteri*[4].	Placerville agreement University of California with UAAAN and COLPOS[4].	Mexico, US

[1] Information presented in the table was acquired from the respective country reports and represents examples of activities.
[2] Report on the State of Canada's Forest Genetics Resources (April 2012)- Table 6.4 (p.140)
[3] Country Report on the State of Forest Genetic Resources- United States of America (June 2012)-(p.49)
[4] Forest Genetics Resources Situation in Mexico-Final report on project TCP/MEX/3301/MEX (4) (Mexico 2012)-(p.93-98)
[5] http://www.camcore.org/overview/

Table 6: Needs for international collaboration on forest genetic resources.

Needs	**Country Level of priority: High (H), Moderate (M), and Low (L)[1]**	
	Canada[2]	**Mexico[3]**
Understanding the state of diversity	H	H
Enhancing *in situ* management and conservation	M	L
Enhancing *ex situ* management and conservation	M	H
Enhancing use of forest genetic resources	M	M

Enhancing research	M	H
Enhancing education and training	H	H
Enhancing legislation	M	M
Enhancing information management and early warning systems for forest genetic resources	H	M
Enhancing public awareness	M	M
Any other priorities for international programs	M	H

[1] Data not determined for the US.
[2] Report on the State of Canada's Forest Genetics Resources (April 2012)-Table 6.3 (p.139)
[3] Forest Genetics Resources Situation in Mexico-Final report on project TCP/MEX/3301/MEX (4) (Mexico 2012)- Table 6.2 (p.100)

Table 7. Examples of needs for the improvement of policies and legislations related to forest genetic resources in North American countries.

Theme	Description
General	• National program for forest genetic resources. [1,2] (Canada, Mexico) • Increase cooperation among national authorities in respect to FGR[2]. (Mexico)
Conservation	• The protection of species is often addressed by different legislation. Consolidation of legislation may streamline activities[1]. (Canada) • Limited application and implementation of regulations on private lands make it challenging for establishing and maintaining *in situ* conservation areas on private lands[1]. (Canada)
Tenure and use rights Supply and use of forest	• Establish mechanisms to ensure that the facility that is contracted annually to supply government reforestation programs, produces in accordance with the provisions on collection, transportation and storage

reproductive material	of forest reproductive material under forest law, so as to ensure the accuracy of the source thereof[2]. (Mexico) • With respect to the purchase of germplasm, give priority to forest producers who are governed by the existing legislation and have banks or storage centers, thus promoting the development of the forest germplasm market with genotypic and/or phenotypic selection[2]. (Mexico) • Ratify the Nagoya protocol while generating laws and regulations under which the protocol can be implemented[2]. (Mexico)
Intellectual property rights **Public participation**	• Development of ABS national policy that includes and involves Aboriginal groups and communities[1]. (Canada)
International	• Collaboration to amalgamate and share knowledge and data across regions for the developing effective long-term strategies for conserving these resources and for either minimizing the impacts of the stressors or for developing scale-appropriate mitigation strategies[1] (Canada).

[1] Report on the State of Canada's Forest Genetics Resources
[2] Forest Genetics Resources Situation in Mexico-Final report on project TCP/MEX/3301/MEX (4)

Table 8. Examples of Capacity-Building, training needs and priorities in conservation, management and use of forest genetic resources in North American countries.

Subjects	Issues	Countries
Genetic diversity assessment	• Research to develop methods for assessing interspecific and intraspecific variation and for monitoring this variation[1]. • Information management concerning the status of species and distribution and trends in genetic diversity (including inter- and intraspecific variation) in a pan-Canadian context to assist decision making pertaining to the conservation and management of forest genetic resources[1]. • Quantify the genetic diversity of species using molecular methods and morphological adaptability studies[2]. • Determine number of populations of priority species and their level of isolation[2].	Canada[1], Mexico[2]
***In situ* conservation**	• Understanding natural selection and adaptation mechanisms for the	Canada[1], Mexico[2], US[3]

	development of genetic diversity requirements (e.g., minimum thresholds, composition, ranges, extent, and distribution) for managing and conserving forests at both the stand and landscape level[1]. • Determining preferred locations for establishing *in situ* conservation areas where they will contain sufficient populations and be buffered against projected climate change (general warming and increased drought risk) and damaging insects and diseases[1]. • Consolidate the current Protected Natural Areas (PNA) and create others to increase representation of ecosystem types in the PNA[2]. • In the restoration of disturbed areas, favour natural regeneration over artificial regeneration to ensure recovery of native species[2]. • Maintain and improve ongoing training programmes for personnel assigned to PNA[2]. • Significant restoration needs, especially following invasive species removals and wildfire[3].	
***Ex situ* conservation**	• Prohibitive cost of developing long-term storage protocols for recalcitrant and orthodox tree seed species[1] • *Ex situ* resources may be used for assisted migration to mitigate changes from climate change[1] • GAP analyses to identify and optimize genetic sampling[1] • Conducting genetic studies and developing micropropagation and cryopreservation techniques for oak species native to the US[3] that have official risk designations (e.g.) red listed. • Increase the delivery of training workshops for producers and technicians in each state, to induce the establishment and certification of production units and storage facilities in accordance with the proposed Mexican Standard of germplasm[2]. • In the concept of support that the federal government grants in the form of subsidies, include support for the maintenance and management of *ex situ* and *in situ* production units, banks and germplasm storage centres[2].	Canada[1], Mexico[2], US[3]
Propagation	• Basic issues such as reproductive biology, phenology, asexual propagation methods, including protocols considering tissue culture for mass propagation and conservation of endangered species, or those with seed production problems[2].	Mexico[2]
Breeding	• Genetic improvement of forest species: genotype tests, selection and	Mexico[2]

	management of outstanding genotypes. Genetic engineering to incorporate desirable features[2].	
General research capacity	• The number of FGR specialist teaching staff should be increased, as well as the infrastructure of laboratories, greenhouses and equipment for research and the training of students[2]. • Promote the exchange of experience and use of facilities, including educational institutions, to streamline available resources[2]. • Expand research agenda for non-timber products and fitness of the species for restoration of disturbed land, landfills and mine waste deposits[2].	Canada[1], Mexico[2]
Academic curricula	• Programs need to reflect a shift from timber-oriented forestry to the "new forestry" described as sustainable forest management and resource management[1]. • Teaching undergraduate and graduate students to ensure future human capacity for continued research in quantitative and molecular genetics[1]. • Generate new curricula and strengthen existing ones, incorporating basic issues such as: basic knowledge of genetics, genetics, biotechnology and molecular biology among others[2]. • Strengthen teacher training to a higher education level and continuously update knowledge in aspects of FGR[2].	Canada[1], Mexico[2]
Stakeholders, Policy	• National program for forest genetic resources with multi-stakeholder participation[1]. • Improve current FGR legislation[2]. • Increase cooperation among national authorities with respect to FGR[3]. • Create a National FGR system[3].	Canada[1], Mexico[2]

[1] Report on the State of Canada's Forest Genetics Resources (April 2012)
[2] Forest Genetics Resources Situation in Mexico-Final report on project TCP/MEX/3301/MEX (4) (Mexico 2012)
[3] Country Report on the state of Forest Genetic Resources- United States of America (June 2012)