A MANAGEMENT PLAN FOR NATIVE OCCURENCES OF EASTERN WHITE CEDAR (*Thuja occidentalis* L.) IN NOVA SCOTIA

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PREFACE AND ACKNOWLEDGEMENTS

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Jurisdiction

Legal responsibility for Nova Scotia's native eastern white cedar occurrences is held by the Government of Nova Scotia Department of Natural Resources, as detailed in the Endangered Species Act (1998).

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1. OVERVIEW

Eastern white cedar (*Thuja occidentalis* L.), referred to as cedar in this document, has been listed under the Nova Scotia Endangered Species Act (1998) as a vulnerable species since 2006. This designation implies that the species is sensitive to human activities and natural events. Land development, forest conversion, land clearing for agriculture, and other land-use practices have influenced the species' condition in Nova Scotia over the past three centuries (Newell 2005). Despite this situation, no native cedar population is formally designated under legislation, which means that most cedar habitat in Nova Scotia remains vulnerable to any type of resource extraction or human activity. However, land procurement bids are progressing in the hopes of preserving certain cedar sites. Nevertheless, with the majority of cedar populations occurring on private land, a stewardship approach in the hopes of conserving the remaining high priority native cedar populations is required. The objective of this document is to prioritize documented native cedar populations for in place (*in situ*) conservation in order to effectively address cedar's vulnerability through stewardship.

This document was prepared by the Nova Scotia Department of Natural Resources (NSDNR), with guidance from scientists familiar with the species' biology, genetics, conservation and management. This document may not necessarily represent the views of all individuals involved in its formulation, or the official positions of the organizations with which reviewers are affiliated. Recommendations identified in this document are based on the best existing knowledge and research, and are subject to modifications based on new available information. The implementation of these recommendations is also subject to appropriations, priorities and budgetary constraints of the participating jurisdictions and organizations. Therefore, some recommendations may not necessarily be implemented immediately, concurrently, or in their entirety.

2. CURRENT KNOWLEDGE

2.1 Life cycle and biology

Cedar is a monoecious gymnosperm belonging to the Cupressaceae family. Individuals can reach ages of 400+ years (Farrar 1995). The oldest cedar documented in Nova Scotia is a 266 year old tree discovered along Cedar Lake in the southwestern region of the province (Campbell 2008). However, under exceptional conservation conditions, 900 year old cedar trees have been found along the shores of Lake Duparquet in boreal Québec (Archambault and Bergeron 1992). Also, exceptionally slow growing specimens over 1,400 years old occur on limestone cliffs off the Niagara Escarpment in southern Ontario (Kelly *et al.* 1994).

According to Johnson (1990), average pollen dispersal and seed cone receptivity period occur from early through to late May. Female cones mature in one season with seed dispersal taking place from early August to February, depending on clinal variation, with most seeds being released by November. Seeds are wind-disseminated, usually travel less than 60 m and do not remain viable on the forest floor longer than one year. Reproductive maturity can be reached as early as age six, with abundant crops occurring at age 30 and optimal production at 75 years. Seeds show slight internal dormancy and have a high drought-related mortality rate. Vegetative reproduction by layering is common in swamps (Johnson 1990), and has been observed in abandoned agricultural fields (de Blois and Bouchard 1995).

2.2 Present distribution

Cedar is endemic to North America's eastern temperate and boreal forests. The species' range extends as far west as Manitoba, and eastward through the provinces of Ontario, Québec, New Brunswick, Prince Edward Island and Nova Scotia. The southern limit of the range occurs in the states of Maine, New Hampshire, Vermont, Michigan, Wisconsin and Minnesota. Outlier populations are found in central Canada and in the southeastern United States (Figure 2.2.1).

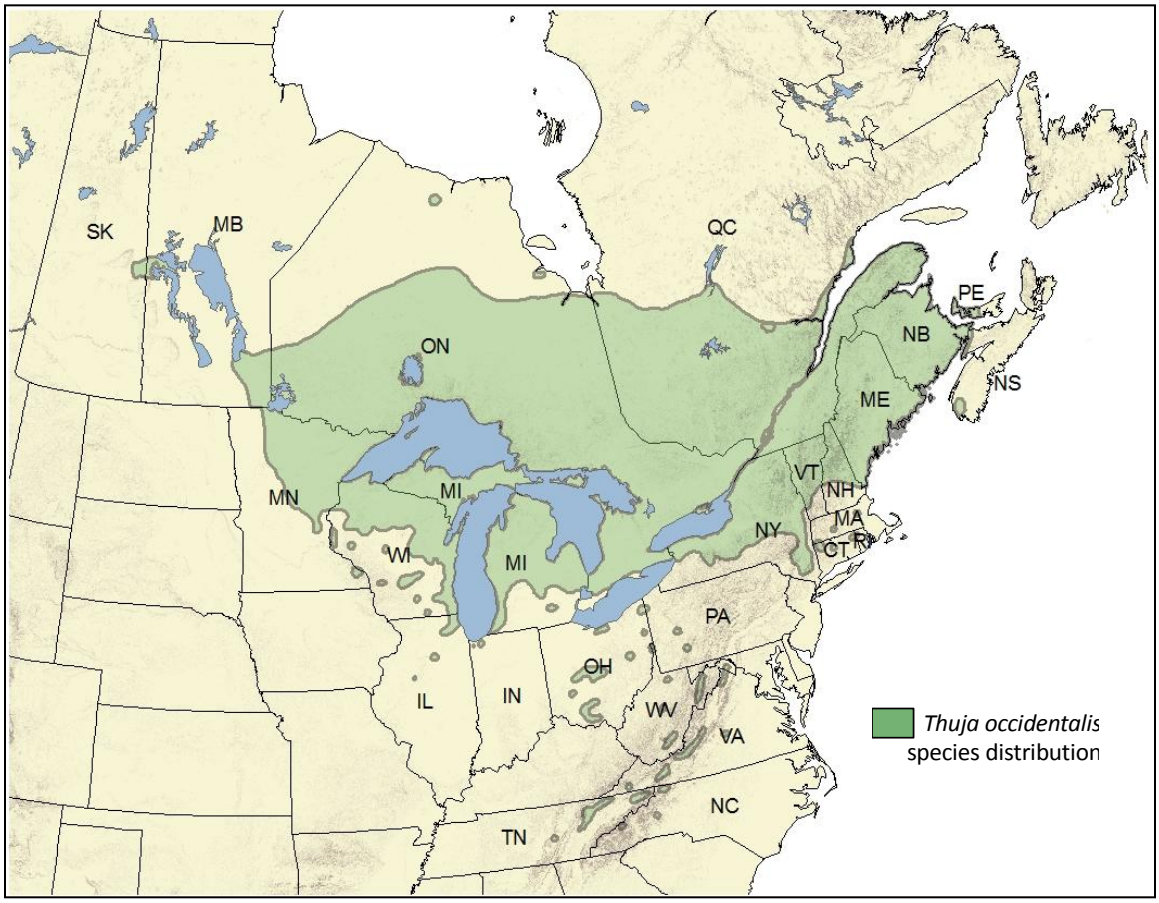


Figure 2.2.1: Range-wide distribution of eastern white cedar (Little 1971).
Abbreviations: Saskatchewan (SK), Manitoba (MB), Ontario (ON), Québec (QC), New Brunswick (NB), Prince Edward Island (PE), Nova Scotia (NS), Maine (ME), New Hampshire (NH), Vermont (VT), Massachusetts (MA), Rhode Island (RI), New York (NY), Pennsylvania (PA), W est Virginia (WV), Virginia (VA), North Carolina (NC), Tennessee (TN), Ohio (OH), Indiana (IN), Illinois (IL), Michigan (MI), Wisconsin (WI) and Minnesota (MN).

Naturally established cedars have been reported at 34 sites in Nova Scotia. These sites are located mostly on private land, scattered across Annapolis, Cumberland, Digby, Kings and Yarmouth counties. Due to their small and localized nature, it is likely that more populations will be discovered in the province (Newell 2005).

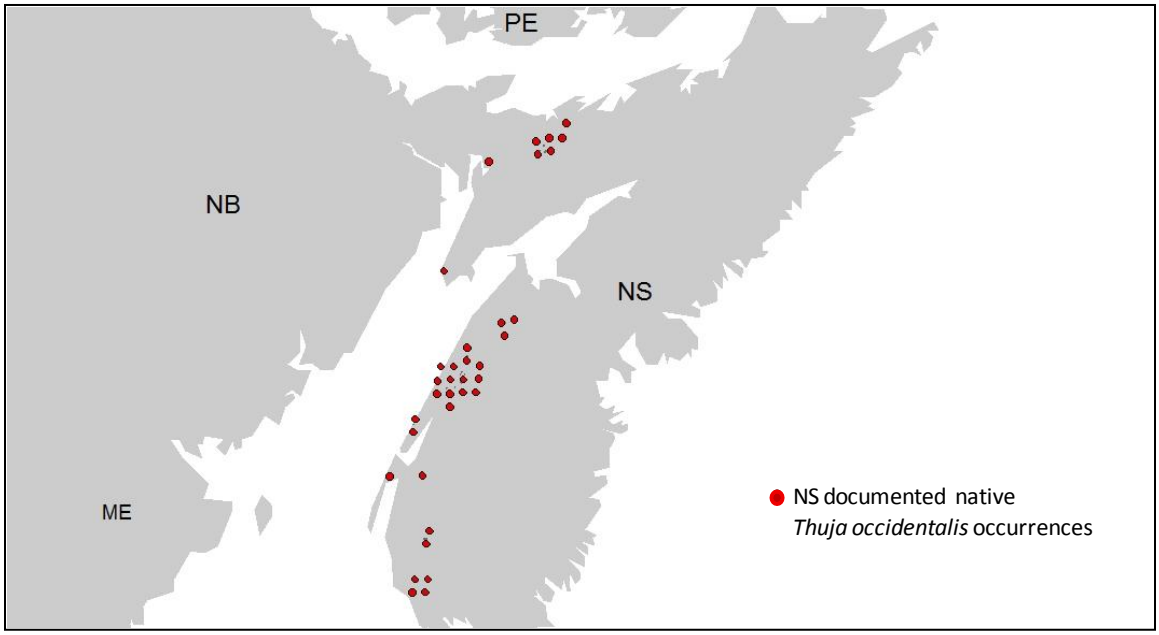


Figure 2.2.2: Nova Scotia's native eastern white cedar occurrence locations.
Abbreviations: Prince Edward Island (PE), Nova Scotia (NS), New Brunswick (NB) and Maine (ME).

2.3 Habitat description of occurrences

According to Johnson (1990), cedar occurs at elevations ranging from near sea level to more than 600 m and can be found in areas between lowland sphagnum bogs and upland hardwood communities. The uplands are primarily mixedwood forests, seepage areas and old fields. The lowland sites include swamps, stream banks and lakeshores. Cedar grows best where soils are neutral to moderately alkaline. On lowland sites, it generally grows where a strong flow of moderately mineral-rich soil water of near neutral pH levels is found. On upland sites, it grows primarily on calcareous soils including calcareous clays and shallow loam overlying broken limestone.

2.3.1 Lowland swamps (including lakesides)

Based on Nova Scotia's provincial Forest Ecosystem Classification Western Ecoregion interim report (2006), the province's cedar swamps and lakeside forests are associated with wet, nutrient-medium to rich organic soils and characterized by a variety of sphagnum species, liverworts, sedges, ferns, decaying logs and litter. Common vegetation includes jewelweed (*Impatiens capensis* Meerb.), sensitive fern (*Onoclea sensibilis* L.), cinnamon fern (*Osmunda cinnamomea* L.), and threeseeded sedge (*Carex trisperma* Dewey). Shrub species found in these forests include poison ivy (*Toxicodendron radicans* L. Kuntze), Canada yew (*Taxus canadensis* Marsh.) and false holly (*Nemopanthus mucronatus* L. Loes.).

2.3.2 Upland mixedwoods

In Nova Scotia, as a component of mixedwood forests, cedar occurs usually in the understory. Red spruce (*Picea rubens* Sarg.), eastern hemlock (*Tsuga canadensis* L.), yellow birch (*Betula alleghaniensis* Britton), red maple (*Acer rubrum* L.) and white ash (*Fraxinus Americana* L.) are commonly observed in the overstory. In general, cedar trees are scattered as single individuals or in small patches throughout the stand (pers. comm. P Neily NSDNR 2008).

2.3.3 Upland old fields

This habitat develops when fields and pastures are abandoned, while a gradual decline of the grass layer results in suitable microsites for the regeneration of conifer tree species such as white spruce (*Picea glauca* Moench Voss), eastern larch (*Larix laricina* [Du Roi] K. Koch), and cedar (NSDNR 2006).

In southwestern Québec, vegetative propagation through layering of standing trees is an important reproductive process that has likely allowed the expansion of old field cedar

forests (de Blois and Bouchard 1995). These forests are considered an early successional community type (NSDNR 2006). Old field forests can evolve towards full grown forests if given enough time, however, it is unclear if old field cedars can maintain themselves in such a context.

2.4 Documented native occurrences

All 34 documented locations of Nova Scotia's native cedar habitat are presented in Table 2.4.1. Although comprehensive forest inventories have not been conducted within provincial cedar occurrences, visual observations reported by NSDNR staff and colleagues provided an estimate of 13,000 to 15,000 trees within Nova Scotia (Newell 2005).

Campbell (2008) analysed tree core data collected from 10 cedar populations (Table 2.4.1). The oldest cedar tree recorded (266 years old) is located in the Cedar Lake II population, and a 194 year old cedar was found in the Hectanooga cedar swamp. This last population is considered having the highest number of mature cedars in the province (Campbell 2008).

Table 2.4.1: Locations of native eastern white cedar occurrences found in Nova Scotia along with oldest tree age and estimated census population size of mature individuals (Newell 2005; pers. comm. L Benjamin NSDNR 2009).

Site name	Latitude	Longitude	Habitat	Oldest tree age*	Estimated mature pop. size
Amherst Point[+]	45.79	-64.26	Mixedwood		4
Barn Brook	44.27	-65.81	Mixedwood & Swamp		< 20
Barnes Lake	44.53	-65.69	Swamp		≈ 50
Black Lake	45.71	-63.93	Mixedwood & Old field	148	≈ 200
Bond Road	45.03	-64.68	Old Field		< 50
Brickton I	44.91	-65.12	Mixedwood & Swamp		≈ 200
Brickton II	44.90	-65.13	Swamp		< 50
Button Brook	44.83	-65.26	Mixedwood		< 50
Cedar Brook	44.80	-65.57	Mixedwood & Old Field	89	≈ 1,000**
Cedar Lake I[++]	44.84	-65.02	Swamp	166	> 100
Cedar Lake II	44.02	-66.12	Mixedwood & Swamp	266	≈ 200
Cedarwood Lake	44.24	-65.87	Mixedwood		1
Churchills Lake	44.06	-66.06	Mixedwood		≈ 300
Daniel's Brook	44.84	-65.25	Old Field	89	≈ 200*
Dockerty's Brook	45.78	-63.62	Mixedwood & Old Field	118	≈ 100*
Eatonville Cedar	45.41	-64.90	Mixedwood		≈ 10
Eel Weir Brook	44.87	-65.15	Old Field		< 50
Haight Brook	44.60	-65.90	Mixedwood		< 50
Hectanooga	44.08	-66.06	Swamp	194	≈ 4,000*
Highway 101	44.87	-65.26	Mixedwood & Old Field		< 50
Lawrencetown Lane	44.87	-65.15	Mixedwood		≈ 100
Ledgehill	44.89	-65.10	Mixedwood		> 100
Litchfield	44.78	-65.58	Mixedwood		≈ 50
Middleton	44.95	-65.04	Swamp & Old Field	125	> 500
Norwood Clearwater Lake	44.06	-66.05	Swamp		< 50
Oxford I	45.73	-63.85	Old Field		< 50
Oxford II	45.73	-63.82	Mixedwood		< 50
Pete's Brook	44.87	-65.13	Mixedwood		< 50
Prospect	45.02	-64.61	Mixedwood		1
Racetrack Brook	45.70	-63.85	Swamp & Old field	127	≈ 500*
Rockland	45.01	-64.70	Old Field		> 500
Thompson Station	44.97	-65.03	Mixedwood		≈ 200
Watton Brook	45.71	-63.82	Mixedwood & Old field	187	≈ 70
West Paradise	44.86	-65.20	Mixedwood		> 200

[+] Potentially planted or seeded from planted trees (pers. comm. S Blaney ACCDC 2010)

[++] Only occurrence entirely located on Nova Scotia provincial crown land

* Campbell (2008)

** pers. comm. B Daigle CFS (2009)

Government owns part of occurrences marked in bold.

2.5 Ownership and protection of native occurrences

Documented native cedar occurrences in Nova Scotia are located on private land, except for Cedar Lake I (Crown), Dockerty's Brook (part Crown, part privately-owned), Hectanooga (mostly privately-owned, small part Crown), Cedar Lake (mostly privately owned, small part Crown) and Amherst Point Migratory Bird Sanctuary (partly Federal and partly privately-owned). No formal protection is currently afforded to native cedar habitat in Nova Scotia.

2.6 Documented occurrences of planted individuals

Three locations harbouring mature cedar trees possibly originating from seed sources non-indigenous to Nova Scotia are shown in Table 2.6.1. Cedar trees present in Acaciaville and Victoria Vale likely originated from a plantation (Newell 2005). The Zwicker Lake cedar occurrence has also been reported to descend from planted trees found on an old homestead in this area (Bentley and Smith 1960). However, the seed provenances of the aforementioned plantations remain unknown. Currently, only the Acaciaville and Victoria Vale occurrences show presence of cedar regeneration (Newell 2005).

Table 2.6.1: Locations and estimated population sizes of Nova Scotia's potentially non-native eastern white cedar occurrences (Newell 2005).

Site name	Latitude	Longitude	Regeneration presence	Estimated mature pop. size
Acaciaville	44.58	-65.75	Yes	> 20
Victoria Vale	45.00	-65.07	Yes	≈ 15
Zwickers Lake	44.74	-65.03	No	≈ 80

There are also records of cedar used for reforestation. NSDNR staff report that, in 1959 approximately 2,700 cedar seedlings were planted around Carleton, Yarmouth County. In addition, 10,000 cedar seedlings were grown at the Tree Breeding Centre in Debert in the late 1990's from native seed sources; outplanting was conducted on municipal land and on private land near Lawrencetown, Annapolis County (Newell 2005).

3. LIMITING FACTORS AND THREATS

3.1 Past human activities

The Maritime Provinces have the longest history of European settlement in Canada. This region has been exploited for wood products and agricultural activities for more than three centuries, which has substantially changed the character of the forest (Loo and Ives 2003). The extensive history of agriculture, forestry, road construction, mining and urbanization in Nova Scotia likely contributed to the decline of cedar (Newell 2005). Indeed, reduced overall number of individuals, decrease in mean population size and forest fragmentation can translate into loss of genetic diversity at both population and species levels. On a long-term perspective, the resulting increase in population differentiation, isolation and inbreeding can further lead to a decrease in the relative reproductive fitness of forest trees (Young and Boyle 2000).

3.2 Current human activities

The long-term persistence of Nova Scotia's cedar populations could be threatened by unsound management practices because the overwhelming majority of cedar occurrences are located on private properties that have no designated protection status. Furthermore, many cedar occurrences found in Nova Scotia are small and may be inadvertently cut. Thus, clearcutting appears to be a likely threat (Newell 2005).

3.3 Abiotic and biotic elements

Cedar possesses natural resistance to most diseases, insect pests and decay (Johnson 1990). In Nova Scotia, documented occurrences of cedar have been observed to be relatively free of disease and insect damage (Newell 2005).

Soil drainage and pH play an important role in the occurrence and performance of cedar over its range (Johnson 1990). Indeed, some believe that Nova Scotia's forest soils are generally too acidic to sustain viable cedar populations, indicating that pH could have been a factor limiting the species dispersal within the province (Newell 2005). Hence, a comprehensive forest inventory of cedar sites would be necessary to assess if neutral to moderately alkaline soils represent the most suited habitats for cedar in the province.

Furthermore, cedar seldom regenerates after forest fire. Its very thin bark with high oil content, the shallowness of its roots (Johnson 1990), and the non-serotinous nature of its cones make it highly susceptible to fire damage. Based on fossil pollen records, Green (1981) inferred that, during the Holocene, not only did major fires destabilize Nova Scotia's early forests by clearing tracts of land on which fire adapted invaders could successfully compete with established populations, but also small fires may have contributed to suppress species, such as cedar.

4. *IN SITU* CONSERVATION

In situ conservation is defined as the conservation of viable populations of species in their natural surroundings, whereas conserving components of biological diversity outside their natural habitat is referred as *ex situ* conservation (FAO, FLD, IPGRI 2004). Albeit there is no exhaustive genetic diversity study of cedar populations in Nova Scotia, the consensus from other research and preliminary findings suggests that significant population differentiation exists among regional occurrences of cedar when populations are fragmented and isolated from one another (Lamy *et al.* 1999; O'Connel *et al.* UNB unpubl.). Furthermore, adaptive variation in cedar has been demonstrated between lowland and upland populations in Wisconsin (Habeck 1958; Musselman *et al.* 1975) and rangewide provenance tests have indicated that significant genetic variation and genotype-environment interaction exist in cedar (Jeffers 1976; Jokela and Cyr 1979).

In the absence of local provenance tests and genetic diversity studies to assess the extent of province-wide population differentiation in Nova Scotia, the best way to delineate conservation zones comprising significant genetic variation in Nova Scotia cedar is to take into account the, ecogeographic (Hamann *et al.* 2005), characteristics found at each occurrence to define provincial provenances. The concept of provenance, signals that geographical features such as climate, topography, soils, fragmentation and spatial isolation, shape the patterns of neutral and adaptive genetic variation in forest tree species (Brown and Hardner 2000). Nova Scotia's Ecological Land Classification (ELC) is a method used to represent the ecogeographical environment affecting the biodiversity of the province's ecosystems (NSDNR 2003). Within the ELC, provincial climate as expressed through soils and vegetation is defined at the ecoregion level (1:500,000), which could be considered as provisional conservation zones for native wind pollinated tree species. By positioning the geographical locations of cedar populations over ecoregion boundaries, Nova Scotia's cedar sites are present in four ecoregions, as shown in Figure 4.1.1

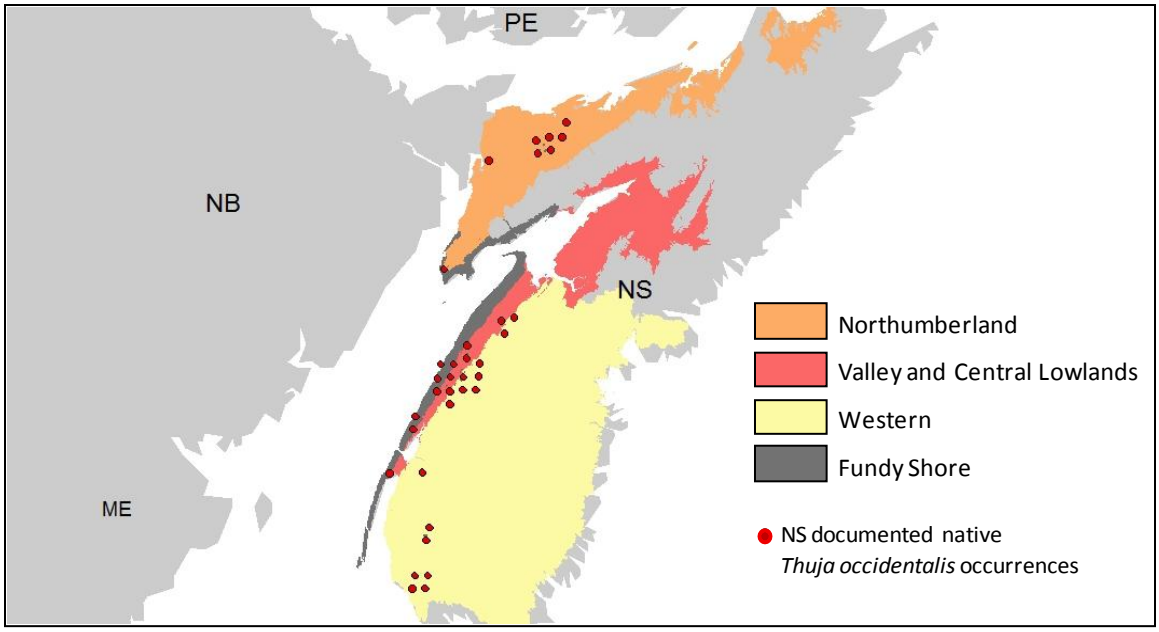


Figure 4.1.1: Nova Scotia's native eastern white cedar occurrences found within 4 provincial ecoregion boundaries.
Abbreviations: New Brunswick (NB), Nova Scotia (NS) and Prince Edward Island (PE).

However, variability within each conservation zone likely exists due to the complexity of interactions between physical and biological attributes. Therefore, one must take into account that cedar grows within different habitats. Lowland swamps and lakesides, as well as upland mixed wood forests, are primary forests that are of first priority for conservation. Upland old field forests or second growth forests do not likely possess the ecological complexity found in primary forests, and therefore should be considered less critical from a conservation perspective.

In Nova Scotia, estimates show that the number of mature trees (census size) among cedar populations varies from a single individual to a maximum of around 4,000 (Newell 2005; Campbell 2008). In terms of *in situ* conservation of quantitative trait genetic variation, populations of at least 150 interbreeding individuals are said to capture in excess of 99% of the variation present in the initial population of a wind pollinated species (FAO, FLD, IPGRI 2004). However, whenever possible, an effective population size that numbers in the thousands should represent an adequate baseline target to

delineate conservation stands, since populations of this size are more likely to sustain themselves over several generations (Lynch 1996; Yanchuck 2001).

Nonetheless, conserving populations that harbour as little as 50 to 80 mature interbreeding individuals can allow for the conservation of basic levels of genetic variation (Yanchuck 2001; FAO, FLD, IPGRI 2004). Therefore, the actual size of a conservation stand is essentially dependent of one's objectives and constraints. Hence, within each ecoregion (conservation zone) boundary where cedar occurs, primary forest habitat and larger population sizes are considered as first priority populations for conservation.

Figure 4.1.2 demonstrates how 15 out of the 34 cedar occurrences were selected as high priority locations for conservation. This filtering technique allows the representation of cedar occurrences within their different ecogeographical environments, to efficiently conserve potential adaptive traits.

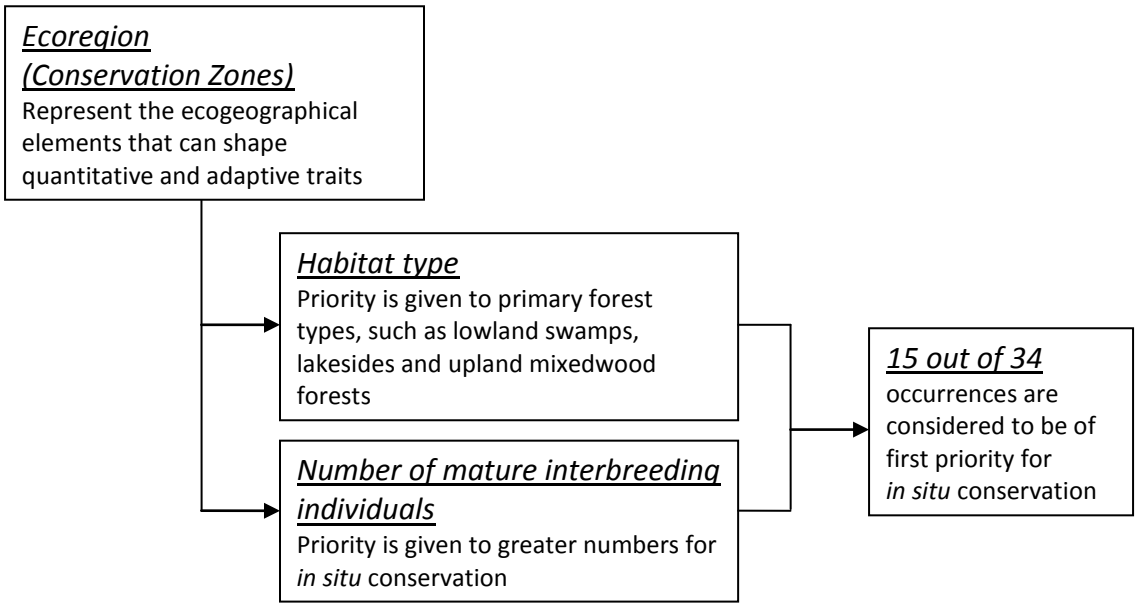


Figure 4.1.2: Schematic representation of filtering technique used to prioritize Nova Scotia's native eastern white cedar occurrences for in situ conservation.

For cedar, the long-term objective is to have these 15 high priority sites (Table 4.1.1 and Figure 4.1.3) represented under *in situ* conservation. In order to protect conservation stands from human manipulation such as logging, mining, urbanization or conversion to agriculture, their formal designation should follow the guidelines of the International Union of Conservation of Nature (IUCN 1994). It is crucial to underline that the Hectanooga site stands out as the largest occurrence of primary cedar forest in Nova Scotia. This location warrants intensive protection. Also found in close proximity of the Hectanooga site is the oldest documented cedar tree in Nova Scotia located in the Cedar Lake II site. Both populations require immediate protection for these unique characteristics.

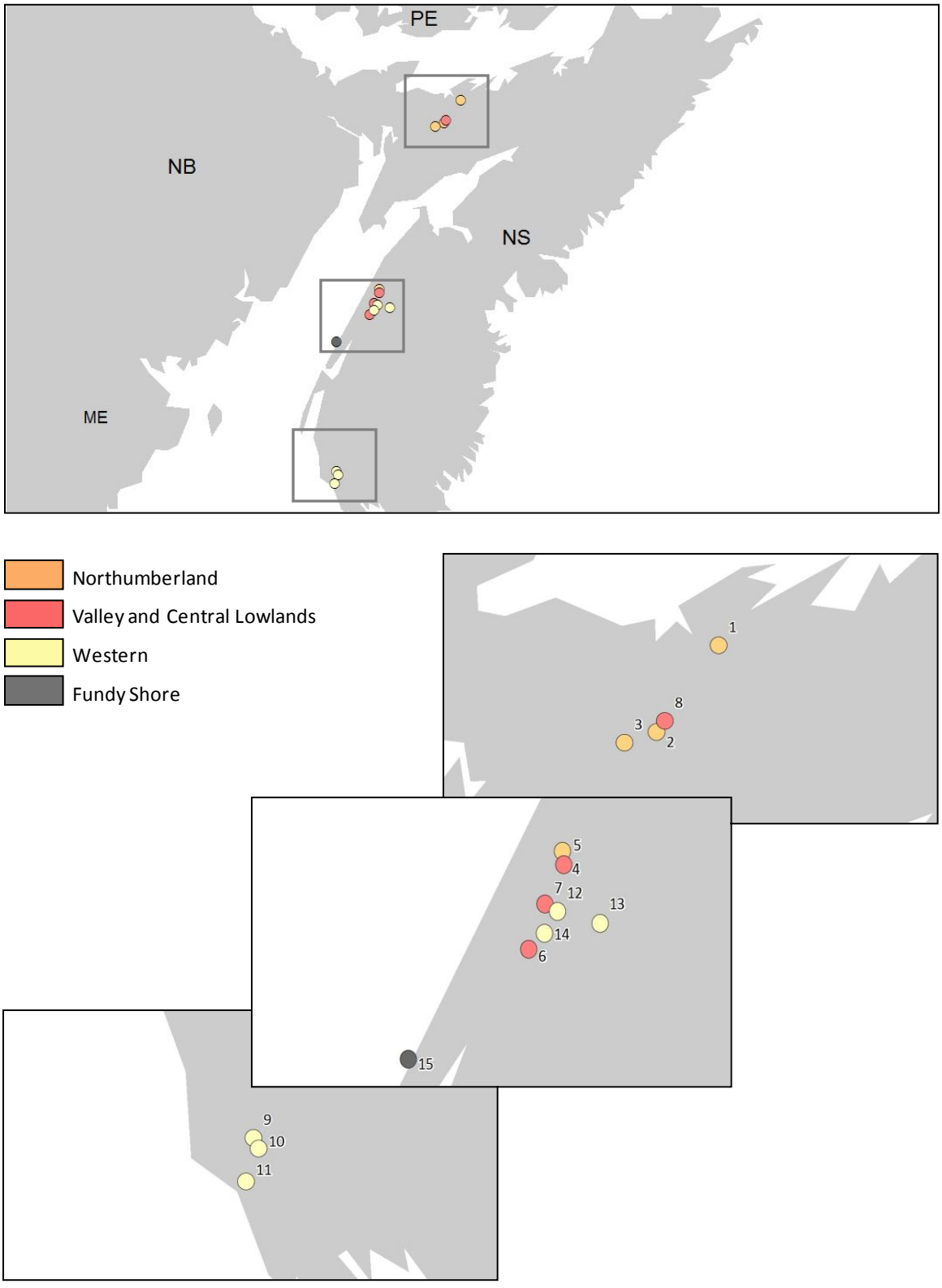
Table 4.1.1: First priority native eastern white cedar occurrences in Nova Scotia sorted by ecoregion (conservation zone), habitat type and estimated census population size of mature individuals.
The provincial government owns part of occurrences marked in bold.

Ecoregion (conservation zone)	Site name	Habitat	Estimated mature pop. size
Northumberland	1. **Dockerty's Brook**	Mixedwood & Old Field	> 500
	2. Racetrack Brook	Swamp & Old field	> 500
	3. Black Lake	Mixedwood & Old Field	≈ 200
	4. Thompson Station	Mixedwood	≈ 200
Valley & central lowlands	5. Middleton	Swamp & Old Field	> 500
	6. West Paradise	Mixedwood	> 200
	7. Brickton I	Mixedwood & Swamp	≈ 200
	8. Watton Brook*	Mixedwood & Old Field	< 100
Western	9. **Hectanooga****	Swamp	≈ 4,000[a]
	10. Churchills Lake	Mixedwood	≈ 300
	11. **Cedar Lake II*****	Mixedwood & Swamp	≈ 200
	12. Ledgehill	Mixedwood	> 100
	13. Cedar Lake I	Swamp	> 100
	14. Lawrencetown Lane	Mixedwood	≈ 100
Fundy Shore	15. Cedar Brook	Mixedwood & Old Field	≈ 1000[b]

* 188 year old cedar tree (Campbell 2008)
[+] Only occurrence under protected status
** 194 year old cedar tree (Campbell 2008)
*** 266 year old cedar tree, oldest in Nova Scotia (Campbell 2008)

[a] Estimated mature population size (Campbell 2008)
[b] Estimated mature population size (pers. comm. B Daigle CFS 2009)

Figure 4.1.3: First priority native eastern white cedar occurrences in Nova Scotia identified by ecoregion (conservation zone).
Abbreviations: Nova Scotia (NS), New Brunswick (NB and Maine (ME).



5. STEWARDSHIP

The *Species at Risk in Nova Scotia Identification & Information Guide* (2008) http://www.speciesatrisk.ca/SARGuide, defines a steward as: "A person aware of the past use of the lands and waters, and mindful of the future; a person wanting to leave things in a state better than they found it." The following stewards have the potential to impact Nova Scotia cedar habitat.

I. Land users and land owners

Individuals who own and/or use areas that may include cedar habitat for development, recreation, or other purposes. For example, farmers, foresters, and recreationists are land users. Land owners are responsible for the activities that take place on their property.

II. Conservation Community

The community of individuals and organizations who work to protect and conserve wildlife and natural resources in Nova Scotia. These groups are instrumental in helping to raise the awareness about cedar to Nova Scotians.

III. Academics and Researchers

Individuals and organizations that will further develop the existing information base on cedar in Nova Scotia.

IV. Government Departments and Agencies

Municipal, provincial and federal departments and agencies responsible for enforcing rules and regulations relevant to cedar conservation. Government Departments and Agencies also have a key role to play in research activities.

V. General Public

People in the community who have the potential to positively or negatively impact cedar habitat, including: recreationists, educators, youth, etc.

NSDNR is committed to see to it that all native cedar occurrences located on crown land be designated as protected areas, following the guidelines of the International Union of Conservation of Nature (IUCN 1994). However, since the majority of the province's cedar occurrences are located on private land, attributing land protection status to native cedar occurrences across Nova Scotia requires a concerted effort. Local individuals and organizations working to protect and conserve natural resources in Nova Scotia are essential stewards to help landowners and forest practitioners understand the need for conservation. These groups are also instrumental in making owners aware of the benefits of involvement in conservation programs, such as private stewardship agreements and conservation easements (Nova Scotia Easements Conservation Act 2001). These programs allow sites to be protected without compromising ownership. Benefits for the landowners could include tax breaks, ease of intergenerational land transfer, and recognition. Hence, in order to successfully implement stewardship actions and secure conservation areas for cedar in Nova Scotia, the ongoing commitment and support of many groups and individuals across the province is a necessity. The key to success requires close and continuing collaboration, dialog and involvement of all stewards.

To gain public support, facts associated with cedar conservation must be well communicated. It is important that land users support the conservation efforts. Ultimately, landowners are responsible for the activities that take place on their property. In order to secure cedar habitat for future generation it will be critical to partner with small private woodlot owners, conservation organisations, municipalities and the forest industry. Other groups in the community, who have the potential to positively impact cedar populations and habitat, such as educators, youth, and

conservationists are also invited to participate in the educational effort. The message should be clear: 1) Cedar in Nova Scotia is rare, and vulnerable to forestry, agriculture, road construction, mining, residential or industrial land development practices, climate change and other anthropogenic activities. 2) We must avoid cutting down cedars on all tenures and legally secure high priority sites for future generations.

All stewards can learn to recognize cedar and report unregistered sightings of native populations; the *Species at Risk in Nova Scotia Identification & Information Guide* (2008) http://www.speciesatrisk.ca/SARGuide offers pertinent pictures and information, that can help identify cedar. NSDNR maintains a significant species and habitat database record system which allows stewards to submit new cedar occurrences by completing a sighting report form http://www.gov.ns.ca/natr/wildlife/web/sigrep.htm. In addition, stewards can report cedar sightings to the species at risk hotline at 1-866-727-3467, email sightings@speciesatrisk.ca, or visit www.speciesatrisk.ca. Keep in mind that it is recommended to take photographs of the cedar habitat, and note the location of the sighting on a map or with Global Positioning System. Also, the development of ecological niche modeling tools (e.g. Pearson 2007) would offer a helpful resource for the identification of unknown occurrences.

NSDNR is committed to survey and monitor the 15 high priority cedar conservation populations (Table 4.1.1 and Figure 4.1.3) to further our current knowledge. Within this context, comprehensive inventory procedures and methods will be developed. In addition, detailed cedar inventories shall provide essential data that is required to find unique characteristics within cedar habitat and will likely improve this plan's *in situ* priority filtering technique. Inventory and monitoring will assist ecologists in determining how cedar sites can maintain themselves when faced with future limiting factors and threats, such as climate change.

PERSONAL COMMUNICATION

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