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Government-Driven Natural Heritage Assessment in Central Ontario and its Application to Canada's Largest Eastern Hemlock Old-growth Forest at Catchacoma Lake, Currently Unprotected

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"*In the short-term, individual groups and societies might profit from forest destruction. However,* ***with old-growth forest vanishing at an unprecedented pace, mankind as a whole loses the ecosystem services provided by these forests****… [including their] spiritual and/or aesthetic nature, genetic resources, non-timber products, habitat for wildlife, the sequestration of carbon, the prevention of floods and erosion, to name only a few... Data on old-growth forests are generally scarce… NGOs involved in the protection of old growth or primary forests need fast and efficient survey methods and, given the land-use pressure on the remaining areas, they cannot afford to waste time."*

(*Old-Growth Forests*, Wirth et al. 2009)

Summary (current abstract from the paper in revision for the ***Natural Areas Journal***)

The recent gap analysis conducted by the Ontario government to assess the natural heritage significance of Canada's largest-known and unprotected eastern hemlock (*Tsuga canadensis*) old-growth landscape – Catchacoma Forest – identified it as a common, fully-represented landscape element that does not require protected status. This decision was based on a methodology that initially filters potential reserves by focussing exclusively on representation of the combinations of forest vegetation with surficial geological composition ignoring many other significant potential reserve selection attributes including forest stand age, ecological integrity, and species-at-risk. The exclusive focus on two of many potential primary reserve attributes can result in ignoring old-growth forests as significant natural heritage features allowing them to be logged. In addition, for old-growth forests, the representation attribute is irrelevant since by virtue of their rare, threatened, and endangered status (low population levels) south of Ontario's Boreal Forest, they are often the first landscape elements to be lost under current conditions if not protected immediately from the impacts of further resource extraction.

Field data were not collected or required as part of the provincial gap analysis methodology. Our field data (reported on elsewhere – see https://www.peterborougholdgrowth.ca/research-reports) confirmed that the Catchacoma Forest is dominated by the old-growth forest condition. Based on tree ages and field assessment of dead wood in 34 random sample plots, roughly half of the plots were in the early old-growth forest stage and the other half of the plots were in the late old-growth forest stage. Stand ages varied from 120 to 224 years, with a mean of 176 years based on tree core aging. Super-canopy trees were present in half of the plots, the forest was regenerating well, and eastern hemlock dominated forest regeneration in three-quarters of the plots. No evidence of logging was observed in 53% of the plots and woodpecker excavations in snags were observed in almost half the plots. Our analysis of Ontario government data indicates that eastern hemlock-dominated forests in central Ontario (~44 million ha) will be depleted due to current logging trends by ~2075 – only about 50 years from now.

Considering 30 key attributes used for reserve selection derived from the literature, including the nine attributes used by the Ontario gap analysis methodology, we found that the Catchacoma Forest is an exemplary old-growth forest candidate reserve. However, a few key, basic features of the Forest alone would typically qualify it for protection including: (1) provincial- and federal-level significance as Canada's largest-known eastern hemlock old-growth forest, (2) the presence of at least 14 associated species-at-risk, and (3) a high level of landscape diversity and integrity including forests, wetlands, streams and lakes undisturbed by humans within a relatively small area of 662 ha – an ideal site for research and education. In this case, the reserve planning process prioritized resource extraction over natural heritage protection increasing endangerment of extremely rare old-growth eastern hemlock forests.

This approach to natural heritage protection in Ontario is also likely resulting in the loss of all types of old-growth forests throughout the ~44 million ha of Ontario where the provincial gap analysis method is applied. We recommend correcting this flaw by updating the 17-year-old gap analysis methodology with assessment of at least 21 additional key natural heritage attributes commonly used for reserve assessment and selection worldwide.

Introduction

Calls for increasing the protection of natural ecosystems at local, regional, and global levels have been accelerating in the last few years (Watson et al. 2018, Brodiea and Watson 2023). Both the *30 x 30 Protection Strategy* (e.g., Jetz et al. 2021) set forth by the Federal Government of Canada and *Criterion 6.5* required for Forest Stewardship Council (FSC) certification (FSC 2022) specify quantitative protection goals. The former strategy states that at least 30% of the land cover in Canada should be protected from development activities, including logging, by the year 2030. There are only seven years remaining to achieve this goal. FSC *Criterion 6.5* requires 20% less protection than the *30 x 30 Strategy* requiring at least 10% of the management area be protected from logging and other forestry activities with no specified completion date (Ontario Nature 2017):

"*The Organization shall identify and protect representative sample areas of native ecosystems and/or restore them to more natural conditions. Where representative sample areas do not exist or are insufficient, The Organization shall restore a proportion of the Management Unit to more natural conditions. The size of the areas and the measures taken for their protection or restoration, including within plantations, shall be proportionate to the conservation status and value of the ecosystems at the landscape level, and the scale, intensity and risk of management activities*." (FSC 2022)

The purpose of this report is two-fold: (1) to conduct a comparative review of the Ontario government's natural heritage assessment methodology (Crins and Kor 2006) and (2) to evaluate the government analysis used to determine that the Catchacoma Forest is a redundant landscape element that does not need protection (MECP 2020). What is not

emphasized by the government method is that representation, which has different meanings at different scales and is applied differently by different practitioners, can and does, at least in the Catchacoma Forest case, dominate over the application of other nature reserve selection attributes. For example, both the Blanding's turtle population and endangered old-growth forests present in the Forest have been ignored (MECP 2020). The requirement of setting aside 1% or 50 ha of each land-vegetation type is far below the *30 x 30 Protection Strategy* put forth by the *Federal Government of Canada* and should be updated to reflect current standards used in Ontario, Canada and worldwide.

Conservation Assessment of Ontario's Eastern Hemlock Forests

Decline of Eastern Hemlock Forests in Ontario

Using the data from Table 1 (see also Quinby 2019a), forests with an eastern hemlock component in Ontario's Area of the Undertaking (AOU; ~44 million ha) made up ~0.4% (~179,463 ha) of this region in 2007. The AOU occupies the region of central Ontario located between Southern Ontario and the Far North, and it is where industrial logging takes place in the province. Further, forests dominated by eastern hemlock (50%+ eastern hemlock; ~37,436 ha) in the AOU made up less than 0.09% of the region in 2007. However, this 15-year-old estimate is high since eastern hemlock forests have been and continue to be logged since 2007 (last FRI data availability). Finally, forests with 100% eastern hemlock composition (295 ha) make up ~0.0067% of the AOU and may potentially be gone by now due to continued logging since 2007. The overall eastern hemlock forest decline of 8% is roughly half of the 16.4% decline of eastern hemlock-dominated forests.

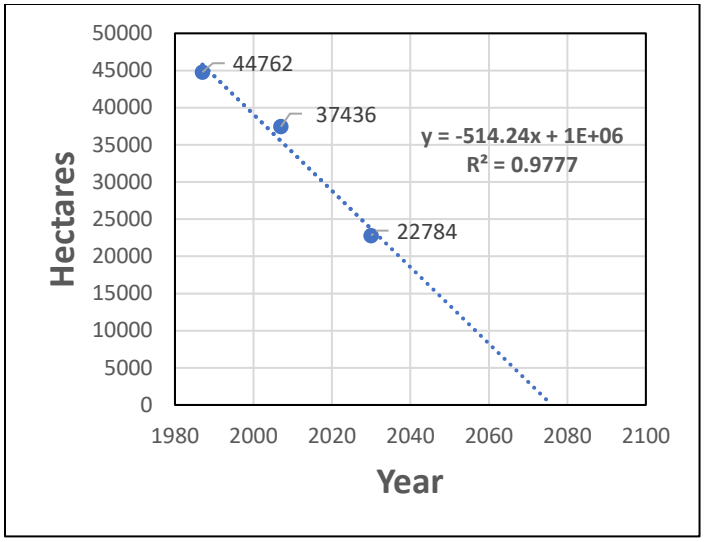
Table 1. Decline of Eastern Hemlock Forests in Ontario over 20 Years (1987-2007) (data from MNRF 1987 and MNRF 2007)

% Hemlock in Stand	1987 FRI Total Area (Ha)	2007 FRI Total Area (Ha)	% Decline Over 20 Years	Growth or Decline
100	752	295	61	decline
90	1,090	780	28	decline
80	3,376	1,884	44	decline
70	7,985	5,765	28	decline
60	13,579	12,938	5	decline
50	17,980	15,774	12	decline
40	21,305	21,331	0	even
30	23,400	22,913	2	decline
20	44,502	40,137	10	decline
10	61,138	57,645	6	decline
Total	**195,107**	**179,463**	**8**	**decline**

Using the difference in the amount of eastern hemlock-dominated forest in 1987 and 2007 (Table 1), and the amount predicted for 2030, a trendline was produced to estimate when this forest type could disappear from the central Ontario landscape (Fig. 1). The amount used for the 2030 point is based on doubling the amount of decline from 1987 to 2007. Doubling was applied due to the Ontario government's current policy to double logging/tree fibre production by the year 2030. The trendline shown in Fig. 1 (R = 0.9777) indicates that eastern hemlock-dominated forests in central Ontario will be depleted due to current logging trends by ~2075 – only about 50 years from now. Similar declines have been documented for other tree species in central Ontario including basswood, American beech, yellow birch, black ash, and white ash (Quinby 2019a).

This precipitous, potentially catastrophic decline of these eastern hemlock-dominated forests should be a conservation wake-up call for all who consider this forest type integral to Ontario's current and future natural heritage. These forests are critically endangered and require immediate attention particularly since hemlock woolly adelgid has been observed only 120 km south of the Catchacoma Forest and continues moving northward.

Figure 1. Decline of Eastern Hemlock Dominated Forest in Ontario's AOU from 1987 to ~2075



Reserve Size - Canada's Largest Old-growth Eastern Hemlock Forest at Catchacoma Lake

Table 2 shows the 26 known eastern hemlock old-growth forest stands in Canada with available size information (see Quinby 2019b for the full report) ranging in size from 5 to 662 ha. Of these 26 stands, 17 are in Ontario, six are in Quebec and three are in Nova Scotia. The nine largest stands are found in Ontario and the largest of all stands is the Catchacoma Forest (662 ha) located at the north end of Catchacoma Lake in northern Peterborough County. Roughly 54% of these stands are protected, not including the Catchacoma Forest.

Reserve Selection Attributes, the Ontario Method, and the Catchacoma Forest Analysis

Review of reserve selection literature from Canada and Europe (Beechey 1989, Gotmark and Nilsson 1992, Crins and Kor 2006 (Ontario government method), Branquart et al. 2008, MNR 2010, Coristine et al. 2018) identified 30 attributes used to select protected areas (reserves) (Appendix A). These attributes are discussed below in the context of representation, ecological functionality, and utilitarian and administrative values. Primary attributes are defined as those used at the first stage of filtering potential reserves into either the rejected group or the retained group. Secondary attributes are defined as (1) those applied only to the potential reserves in the retained group following primary attribute evaluation and/or (2) those considered of minor importance by a given method.

The application of the Ontario method (Crins and Kor 2006) to the Catchacoma Forest natural heritage analysis (MECP 2020) is assessed in this section. In total, 23 additional primary attributes beyond those used by the Ontario method have been used to select reserves in Canada and Europe (Appendix A). Only two attributes were used to evaluate the Catchacoma Forest; at least 28 additional attributes should be applied to evaluating the natural heritage values of this exceptional, nationally significant forested landscape. In addition, compared to all other methods in Appendix A, the Ontario method relied far more heavily on secondary attributes for natural heritage assessment. For the Catchacoma Forest analysis, no secondary attributes were considered.

Representation

Seven selection attributes were identified from the literature (Appendix A – Part 1) that address representation of: *natural terrestrial ecosystems*; *rare, threatened, endangered, and endemic species*; *physiography and geology*; *natural aquatic ecosystems*; *special habitats*; *palaeoecological sites*; and *modified ecosystems with special scientific, research, and/or educational value*. The Ontario government method (Crins and Kor 2006) applies representation of *natural terrestrial ecosystems* in combination with representation of *physiography and geology* (land-vegetation type) as the first, primary reserve selection filter. The four primary representation attributes not used by the Ontario method include *natural aquatic ecosystems*; *rare, threatened, endangered, and endemic species*; *special/significant habitats*; and *palaeoecological sites* (Appendix A – Part 1).

Table 2 – Known Old-growth Eastern Hemlock Forests in Canada with Size Data (from Quinby 2019b)

Site Name	Province	Area of Old-growth Hemlock (ha)	Protection Status
Catchacoma Lake Old-growth Hemlock Forest	***Ontario***	***662***	***NO***
Clear Lake Conservation Reserve	Ontario	453	YES
North Tea and Cayuga Lakes Old-growth Hemlock Forest	Ontario	406	partial
Raganooter Lake Conservation Reserve	Ontario	311	YES
DeGaulle Lake Old-growth Hemlock Forest	Ontario	305	NO
Gold Lake Old-growth Hemlock Forest	Ontario	285	NO
Lost Dog Lake West Old-growth Forest Cluster	Ontario	192	partial
Algonquin Park (>100 ha; <281 ha; 28 stands)	Ontario	190 (100-280)	YES
High Park	Ontario	160	YES
Booth Lake Eastern Hemlock Old-growth Forest	Quebec	152	unknown
Wesleyville Ravines	Ontario	138	YES
Lost Dog Lake Central Old-growth Hemlock Forest	Ontario	79	partial
Echo Lake Ancient Forest	Quebec	56	YES
Panuke Lake Nature Reserve	Nova Scotia	47	YES
Gagnon Lake Eastern Hemlock Old-growth Forest	Quebec	45	unknown
Devlin Lake Eastern Hemlock Old-growth Forest	Quebec	31	unknown
Sisco Lake Old-growth Hemlock Forest	Ontario	29	partial
Sporting Lake Nature Reserve	Nova Scotia	25	YES
Gillies Grove	Ontario	25	YES
Preston Lake Eastern Hemlock Old-growth Forest	Quebec	20	unknown
Balls Falls Gorge (Twenty Valley)	Ontario	20	YES
Mckeel Woods Eastern Hemlock Old-growth Forest	Quebec	17	unknown
Decew Falls and Gorge	Ontario	11	YES
Durland Lake Old-growth Forest	Nova Scotia	10	YES
Jackson Creek Old-growth Forest	Ontario	5	YES
Hemlock Valley	Ontario	5	YES

Secondary criteria activate only for those reserves that have not been rejected at the first stage of selection, even though rejected reserves may have excellent additional (primary and secondary) attributes not utilized by the Ontario method. Three secondary attributes are available for application by the Ontario method and include *rare, threatened, endangered, and endemic species*; *natural aquatic ecosystems*; and *special/significant habitats*. The only unused secondary criterion by the Ontario method is applied by two other methods - Beechey (1989) for Canada and Gotmark and Nilsson (1992) for Sweden. This attribute is *modified ecosystems with special scientific, research, and/or educational value*.

The application of the Ontario method to the Catchacoma Forest (MECP 2020) utilized only two primary attributes - representation of *natural terrestrial ecosystems* in combination with representation of *physiography and geology* (land-vegetation type). All other potential primary and secondary selection attributes (e.g., stand age, species-at-risk, etc.), were excluded in the MECP (2020) natural heritage analysis for the Forest.

Ecological Functionality

A total of 16 reserve selection attributes that address ecological functionality were identified in the literature (Appendix A – Part 2) including: *habitat, community, and species diversity*; *rarity*; *size*; *integrity*; *human disturbance*; *connectivity*; *fragility*; *replication*; *shape*; *interior habitat*; *potential to persist*; *endangerment*; *significance*; *distribution*; *climate change resilience*; and *old-growth forest continuity*.

None of the attributes in this category are used as primary attributes by the Ontario method, however, four of these attributes are considered secondary attributes by the Ontario method including *habitat*; *community and species diversity*; *rarity*; and *connectivity*. None of the other methods reviewed used secondary attributes in this natural heritage category; instead, all 16 of these attributes are applied as primary attributes by the other methods (Appendix A – Part 2). Finally, none of these attributes were applied by the MECP (2020) natural heritage analysis of the Catchacoma Forest despite the relevance of each attribute to the ecology and conservation of the Forest.

Utilitarian and Administrative Values

Seven selection attributes that address utilitarian and administrative values were identified in the literature including: *significance already established*, *potential for stewardship*, *protection in place*, *scientific value*, *educational value*, *nature appreciation*, and *accessibility* (Appendix A – Part 3). None of these attributes are included in the Ontario method (Crins and Kor 2006) and none of them were applied by the MECP (2020) analysis of the Catchacoma Forest. Three of these seven attributes were used as primary selection attributes by other reviewed methods including: *significance established*, *stewardship potential*, and *protection in place*. All seven of these attributes, particularly *science, education, accessibility* and *protection in place*, apply in exemplary fashion to the Catchacoma Forest. When these attributes are not considered in reserve selection, forests are undervalued increasing the risk of damage and loss to society resulting in further environmental decline.

Unique Features of the Catchacoma Forest

The Catchacoma Forest is currently designated for "contingency" logging and could be converted to "allocated" logging if the MNRF decides to allow it. Since (1) old-growth forests are endangered in central Ontario, (2) natural eastern hemlock forests are extremely rare in Canada, and (3) the Catchacoma Forest is Canada's largest remaining eastern hemlock old-growth forest (there are many other good reasons), the Forest should be designated as a protected area immediately.

The *representation* attribute is irrelevant since all rare, threatened, and endangered ecosystems within central Ontario, particularly old-growth forests, should be protected to ensure that they are not lost forever. These forests are the most vulnerable of all the forest ages given their extremely high wood biomass content, which is highly sought after by logging companies. Obrien et al. (2023) state that the Catchacoma Forest is regionally significant for its wildlife connectivity and carbon storage values based on their study using remotely sensed data unassociated with digital Ontario Forest Resource Inventory mapping.

By protecting the Catchacoma Forest as a community-based reserve for non-consumptive use that is inclusive of all interested parties, this reserve would not provide timber for products such as pallets and garden mulch that are produced from eastern hemlock trees. However, protection would provide the following benefits (and more) to society at local to international scales since eastern hemlock forest is common throughout the temperate portions of eastern Canada and throughout eastern United States.

- spiritual respite and renewal
- physiological and mental health benefits to people who are emersed within the forest
- provides for the continuation of existing recreational activities with potential for more light trail-based recreational activities
- both formal and informal education
- scientific study of landscape baseline conditions including carbon dynamics and biodiversity conservation
- long-term studies as the best way to truly understand nature (656 species found to date)
- storage and sequestration of CO_2 as global temperature continues to rise
- provide habitat for rare, threatened, and endangered species (14 SARs found to date)
- provide for the most natural conditions possible to support natural evolution (unimpeded by humans)
- to function as a sentinel of biological invasions (e.g., hemlock woolly adelgid) that are on the rise globally
- adds a separate and contiguous area to Kawartha Highlands Provincial Park making the region more resilient to both climate change and biodiversity loss

From an economic perspective, the Catchacoma Forest is at least 10 times more valuable if left unlogged (Collings and Quinby 2020) and logging contingency areas are available to replace the removal of 662 ha from the productive forest. To not protect the Catchacoma Forest from logging is to miss a significant opportunity to address two issues that are extremely important to the public, including the positive public relations that could be achieved. In addition, the Bancroft Minden Forest Company/MNRF/MECP could decrease the amount of protection required by the *30 x 30 Strategy* for their logging region down to 207,388 ha if logging was removed and the 662 ha were converted to protected status.

A comprehensive natural heritage values assessment is provided in ***AFER Research Report No. 41***. This research report (#41) and Appendix A are the basis for a research article currently in revision with the ***Natural Areas Journal***.

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Appendix A - Reserve Selection Attributes from Canada and Europe – Part 1: Representation Values

Attributes	Southern Ontario (Natural Heritage Manual MNR 2010)	Canada (Beechey 1989)	Canada (Coristine et al. 2018)	Europe (Branquart et al. 2008)	Sweden (Gotmark and Nilsson 1992)	Ontario AOU (Crins and Kor 2006)
Total Number of Primary Attributes (P)	**17**	**16**	**11**	**9**	**6**	**2**
Total Number of Secondary Attributes (S)	**0**	**5**	**0**	**0**	**5**	**7**
Representation Values						
Natural Terrestrial Ecosystems	**P**	**P**	**P**	**P**	**P**	**P**
Rare, Threatened, Endangered, Endemic, etc. (genetic and evolutionary conservation)	**P**	**P**	**P**	**P**	**P**	**S**
Physiography and Geology (e.g., habitat conditions)	**P**	**P**	**P**		**P**	**P**
Natural Aquatic Ecosystems	**P**	**P**	**P**		**S**	**S**
Special Habitats (e.g., hibernacula, calving grounds, denning and feeding sites, etc.)	**P**	**P**				**S**
Palaeoecological Sites (important fossil sites - e.g., pollen banks, to study prehistoric ecological succession and evolutionary change)		**P**				
Modified Ecosystems with special scientific, research, and/or educational value		**S**			**S**	

APP A – Part 2: Ecological Functionality Values

Attributes	Southern Ontario (Natural Heritage Manual MNR 2010)	Canada (Beechey 1989)	Canada (Coristine et al. 2018)	Europe (Branquart et al. 2008)	Sweden (Gotmark and Nilsson 1992)	Ontario AOU (Crins and Kor 2006)
Total Number of Primary Attributes (P)	**17**	**16**	**11**	**9**	**6**	**2**
Total Number of Secondary Attributes (S)	**0**	**5**	**0**	**0**	**5**	**7**
Ecological Functionality Values						
Habitat, Community, and Species Diversity	**P**	**P**	**P**	**P**	**P**	**S**
Rarity (relative scarcity of an ecological feature, phenomenon of national importance take priority over those of regional or local interest)	**P**	**P**	**P**	**P**	**P**	**S**
Size (large sites favored over small sites, reduced extirpation potential, better for re-colonization, minimize edge effect)	**P**	**P**	**P**	**P**		
Integrity (incorporate whole viable systems into protected ecological areas thereby minimizing extrinsic biophysical impacts)	**P**	**P**	**P**	**P**		
Human Disturbance (degree of human disturbance, particularly important when selecting benchmark sites, human disturbance may be disqualifying)		**P**	**P**	**P**		**S**
Connectivity (migration routes for diverse species)	**P**		**P**	**P**		**S**
Fragility (the ability of an area to tolerate use)	**P**	**P**				
Replication (two or more examples of a phenomena broadens opportunities for protecting the phenomena variation and studying the causative factors)	**P**	**P**				
Shape (a wide core area is better than a narrow one, a high interior to edge ratio is better than a low one)	**P**					
Interior Habitat (habitat more than 100 m from the edge)	**P**					
Potential to Persist (if land use changes have already occurred or been approved that are deleterious, the site may not be a good choice)	**P**					

Endangerment (uncommon ecosystems under pressure for conversion to other land uses should receive priority for protection)		**P**				
Significance (rank areas on the basis of all criteria to determine their overall relative significance, insures that protection efforts are concentrated on the most important sites)		**P**				
Distribution (accessibility and use may influence the selection of sites)		**P**				
Climate Change Resilience (protect climate refugia)			**P**			
Old-growth Forest Continuity (over time, including dead wood)				**P**	**P**	

APP A – Part 3: Utilitarian and Administrative Values

Attributes	Southern Ontario (Natural Heritage Manual MNR 2010)	Canada (Beechey 1989)	Canada (Coristine et al. 2018)	Europe (Branquart et al. 2008)	Sweden (Gotmark and Nilsson 1992)	Ontario AOU (Crins and Kor 2006)
Total Number of Primary Attributes (P)	**17**	**16**	**11**	**9**	**6**	**2**
Total Number of Secondary Attributes (S)	**0**	**5**	**0**	**0**	**5**	**7**
Utilitarian & Administrative Values						
Significance already Established (presence of one or more provincially significant features)	**P**					
Potential for Stewardship (potential to be enlarged and/or improved)	**P**					
Protection in Place (ownership or legal interest provides a secure future)	**P**					
Scientific Value (importance of the site for study and research, established research enhances the value of a site for future investigations and environmental monitoring)		**S**			**S**	
Educational Value (the range of features within a particular site largely determines its potential for educational use)		**S**			**S**	

Nature Appreciation (a function of the ecological values being protected)		**S**			**S**	
Accessibility (depends on use pressures)		**S**				