Review of Neily, P.D., E.J. Quigley, B.J. Stewart, and K.S. Keys. 2007. Forest disturbance ecology in Nova Scotia. Nova Scotia Department of Natural Resources (draft).

Submitted to NSDNR by Minga O'Brien, MSc, Dalhousie University

Key points:

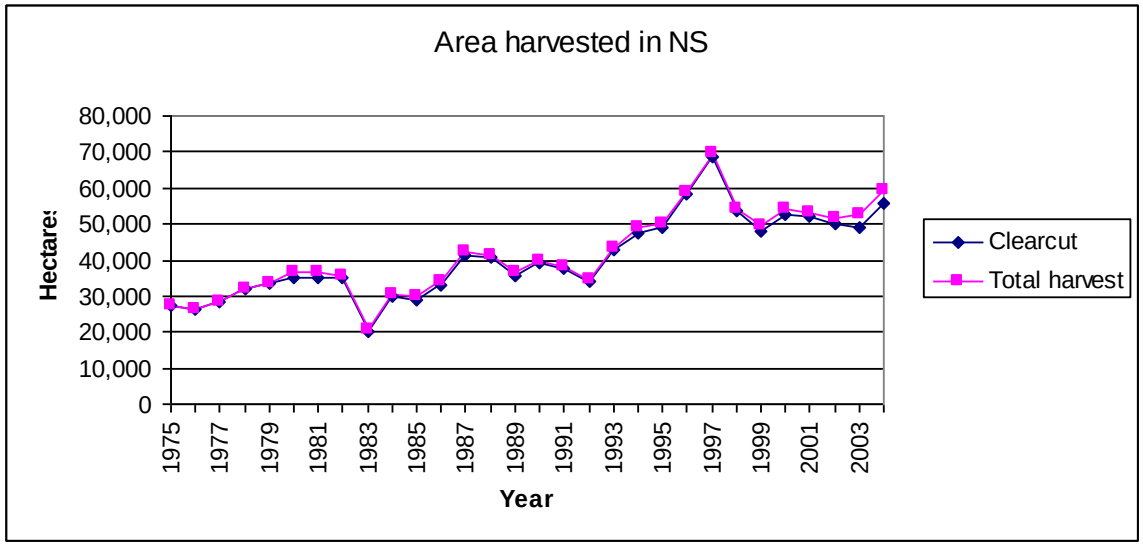
- Earlier drafts of this report attempted to provide guidance on emulation silviculture. However, the intent and future use of this version of the report is not clear; what recommendations will come from it, how will they be determined, and by whom?
- The methodology explaining the assignment of climax forest type and dominant natural disturbance regime in Appendix III is inadequate. It is questionable if others could use this methodology and come up with the same results. The numbers in Table 5 vary considerably from other estimates of the extent and return interval of natural disturbance regimes for this region. No explanation is offered for these discrepancies.
- Ecologists on the government's Ecological Technical Committee have expressed reservations with this report. Extensive comments were submitted to the report's authors, citing much of the relevant literature on this topic. These comments are not reflected in the most recent draft of this report. What is the explanation for this?
- The report makes no reference to the spatial extent of the largest forest disturbance in the province: clearcutting of over 50,000 hectares per year. At this scale and frequency, forest harvesting has done more to shape the composition, age and structure of our forests than any other single disturbance factor.
- Data available from Hurricane Juan should have been used to describe the actual extent of blowdown from one of the largest hurricanes ever to affect Canada.
- If this report is a briefing paper, then it should be looking at the key publications from this region. Seymour, White and deMaynadier (2002) is likely the most authoritative publication on natural disturbances and emulation silviculture for the Acadian forest region, but is not cited once in this report. Similarly, Mosseler et al. (2003) is the most credible and comprehensive description of old growth Acadian forests.
- The report relies heavily on a study by Basquill et al. (2001) that is not peer-reviewed.
- Appendix III indicates that black spruce in Nova Scotia is regenerated exclusively by frequent stand initiating events like wind, insects and fire. Where are the data to support this?

General comments

1. The report does not adequately define what type of disturbance it reviews, switching between *forest* disturbance, apparently including human causes, and *natural* disturbance. For example, these statements appear contradictory: -

"This report describes and summarizes the *natural disturbance* regimes and agents thought to be acting on the forest ecosystems of Nova Scotia."; and "The secondary purpose of the report was to put under one cover a review of the historical records of provincial *forest disturbance*".

2. There is almost no recognition of the effects of forest harvesting on the current composition and age class structure of Nova Scotia forests. Even Appendix 1, which provides "a partial summary of the natural and human-caused disturbances in NS …that have influenced the composition of NS's forests over the last 400 years" manages not to mention forest harvesting. This is remarkable, given the extent to which forest harvesting practices have and continue to alter the composition and extent of Nova Scotia's forests. The area clearcut since 1975 is depicted below (CCFM 2007).



More than 1.25 million hectares have been harvested in NS since 1975, 97.5% by clearcutting (including 1-stage, 2-stage, shelterwood and seed tree cuts). This averages out to almost 42,000 hectares harvested per year since 1975, and over 53,000 hectares clearcut each year since 1995.

The 2004 version of this report had the following text:

> "The area of forest disturbed due to timber harvesting can be roughly calculated using a predetermined volume per hectare and the annual harvest records….. Assuming an average yield of 120 m^3 per hectare it can be calculated that in 1929 nearly 17,000 hectares were harvested (Anon. 2003). By 1981 the annual harvest was derived from 36,000 hectares until in 2003 the calculation indicates that close to 50,000 hectares are used to meet the demand for wood."

If the purpose of this report is to discuss all disturbance agents, it should supply sufficient spatial information that anthropogenic disturbances can be compared to natural disturbances. Was the above information omitted and replaced with one sentence that refers to volumes of wood

harvested in 1929 and 2003? Almost all the other forest disturbance information in this report, including the information summarized in Table 5, is presented in hectares or other spatial units.

3. The authors use phrases and present lists and a map that suggest wind plays a major role in creating frequent, stand initiating natural disturbances in NS. For example, adjectives like 'catastrophic', 'destroyed', 'devastated', 'extensive damage', and 'vulnerable' are peppered throughout, as well as phrases like "Nova Scotia's forests are especially vulnerable to storms and hurricanes"; "Hurricanes and winter storms also played a prominent role in shaping the coastal forests", and "Over the past couple of centuries more than 20 major storms of hurricane intensity have affected NS".

According to the Canadian Hurricane Centre, "Juan was one of the most powerful and damaging hurricanes ever to affect Canada". Yet when the blowdown was quantified, only 5% of the forested portion of the storm swath underwent 30-100% blowdown - or 23,000 ha (roughly 0.55% of Nova Scotia's forests) (NSDNR pers. comm. 2007). If Juan-scale events were to occur every 50 years, on average 0.55%/ 50 or 0.01% (1/10,000) of the province would be affected by moderate-severe (30-100%) blowdown every year. In a review of the existing literature, Seymour et al. (2002) quoted return intervals of 855–14,300 years for stand-replacing wind disturbances.

One must also consider the effects of changes to forest composition and the forested landscape that exacerbate the effects of wind storms, for example, management practices that favour shallow-rooted softwoods, and increased vulnerability to blowdown created by clearcuts, fields, roads, etc.

4. The first quote in the report: 'the larger message is that there was no fixed "original landscape"', and ongoing literature references suggest it is very difficult to characterize the pre-settlement forest as it was unstable. I disagree. Mosseler et al. (2003) did a very fine job of characterizing the pre-settlement Acadian forest. Furthermore, such a suggestion undermines the methodology employed by the report's own authors in assigning climax forest type and natural disturbance regimes (NDR).

The theory behind emulation silviculture and ecological forestry is that any manipulation of a forest ecosystem should emulate the natural disturbance patterns of the region *prior to extensive human alternation*. This is based on the assumption that native species have evolved under these natural disturbance regimes and will be better able to cope with human-induced disturbances such as logging if they are designed to imitate the key characteristics of natural disturbances, including the return interval between disturbances, disturbance severity, and spatial pattern of disturbances (Seymour and Hunter 1999).

As noted throughout this report, and in information obtained through a FOIPOP request, if someone wanted to duplicate their efforts they would first have to produce a potential climax forest table for each of the ecoregions and their ecodistricts, and based on climax forest, assign dominant natural disturbance regime. Presumably, the authors have used enduring features, the existing forest, historical information and other clues to determine climax forest type. Given the significant changes in forest composition and structure in the last 400 years – most of which have been anthropogenic or exacerbated by anthropogenic influences, potential climax forest type is often very different from current forest types. Thus it is difficult to understand why, in the introduction to this report, the authors state they are providing information on the disturbances "that have created the *current* composition and extent of forests in Nova Scotia." If this were

really the case, they should have dedicated the majority of the report to the history of anthropogenic stressors on Nova Scotia's forests.

5. The authors state "The primary purpose of this report is to set the stage for examining the concept of natural disturbance based management for Nova Scotia's forest. The intent of the report was not to provide an exhaustive review of natural disturbance-based management - there are excellent reports already published and peer reviewed on this topic.", and "this review included literature specific to the province or the Maritime portion of the Acadian Forest region." First, there is no excuse for ignoring the most cutting-edge, credible and thorough publications on this topic for our region, such as the 2002 *Forest Ecology and Management* article by Seymour, White and DeMaynadier. Second, there is no sudden change in climate, biophysical features and soils at the Canada/US border. There may even be greater variability in forest composition and dynamics within the Maritimes than between the Maritimes and Maine. By being selective, the authors are choosing to omit research from the Northeastern US, including the University of Maine, which is an epicenter of disturbance ecology and emulation silviculture research in the Acadian Forest region.

In addition to research out of University of Maine, the authors need to be more thorough in their use of research from the Maritimes, such as Bentley and Smith (1956), Blais (1983), Green (1987), Lutz (1996), Morris (1761), Mosseler et al. (2003), Mott (1975), and Ponomarenko (2007, 2000). More recently, Donna Crossland completed an MSc. thesis with the UNB Forestry Department on disturbance ecology in the Northumberland Strait area (Crossland 2006), and Elena Ponomarenko has completed her first year of research reconstructing fire history at Kejimkujik National Park (Ponomarenko 2007).

Instead, the authors rely heavily on Basquill et al. (2001), which reports on the history and ecology of fire at Kejimkujik National Park (Keji). Some of the problems with relying on this study include:

1) This is not a peer-reviewed report. It was published by Parks Canada. The report does not clearly outline how calculations were used to derive such a short fire cycle.

2) Basquill computed a fire cycle (78 years) that is shorter than what is calculated for boreal forest; it was too short to produce an old growth hemlock stand, or anything else beyond jack pine, aspen and other early successional spp.

3) This report reveals little about Acadian forest disturbance ecology beyond the fact that fire was frequent during post-European settlement times. The methods provided to researchers at Keji were inappropriate for researching fire history prior to European contact in eastern Canada. Most trees do not date back to pre-European time, so fire scar dates will indicate *only* recent fires, the vast majority of which originated from anthropogenic ignition sources. In fact, Basquill et al. (2001) states that "*No very large or old trees were cut in recognition of their rare status*".

4) No radio-carbon dating was carried out to distinguish pre- and post- European fire events. Charcoal found in the soil was linked to the age of the dominant forest canopy, and hence computed as "time since the fire event", though the charcoal could have originated from several tree generations prior to the current forest stand. (Charcoal can endure in the soil indefinitely.)

5) Judging by the methods, all hemlock stands found in Keji were assumed to be post-fire stands. However hemlock is considered by most to be a fire-sensitive, late successional species.

6) Basquill's report proves that fire was on the landscape in Keji, but the report says little about the inherent fire regime that would operate on the Keji landscape without human interference. Large repetitive fires are associated with early European land clearances, and later with the advent of steam engine trains, as well as other anthropogenic ignition sources. The vast majority of the fires that Basquill detected were most likely from these sources.

7) Neily et al. may have believed that a fire history study stemming from a national park implies a non-human altered, natural fire regime. In fact, Kejimkujik National Park (established in 1974) had numerous homesteads and cottages, and was farmed and selectively logged. Many forest stands in Keji are in the process of recovering from extensive human disturbance.

6. For many reviewing this report, its *intent* is still not clear. Earlier versions of this report had a table that recommended silviculture systems for various disturbance regimes (see below). This table is not in the current version of the report, and we're told, instead, "The report provides no conclusions or recommendations, and as such could be seen as a briefing paper. Any course of action resulting from this report will be a product of further discussion within the Department." Emulation silviculture is a key component of ecosystem management. The recommendations and conclusions from this briefing paper need to be transparent and scientifically-sound, and this would suggest they be discussed not just *within* NSDNR. What assurance does the public and the scientific community have that decisions will have scientific merit? Also, if this is a briefing paper, then it should, at a minimum, look at the key publications and documents on natural disturbance ecology from this region. If there are significant disparities with this report, they should be explained.

Table 8 – Applications for silviculture systems that provide structure and processes similar to natural disturbance regimes.

Dominant Disturbance Regime	**Silviculture Systems**	**Provincial Forest***	
		Area (ha)	**(%)**
Frequent Stand Initiating	Clearcut for stand renewal	1 775 000	42
Infrequent Stand Initiating	Clearcut (long rotation) Shelterwood (two-aged, advance regeneration) Selection	1 480 000	35
Gap Dynamics	Selection	972 000	23

Stand Maintaining	Shelterwood/Selection (tending for preferred species)		
	Total	4 227 000	100

Detailed comments

p.4, last paragraph

-disturbances rarely *remove* or kill *all* the existing trees above the forest floor vegetation

-as noted above, Hurricane Juan was one of the most powerful hurricanes ever to hit Canada, and results show that only 5% of the hurricane swath underwent moderate to severe blowdown (30-100% stems downed); similarly, fires are highly variable in intensity and severity of impact

p.5 – reflects on how humans have affected the frequency, intensity and magnitude of natural disturbance processes

- this should give the authors more reason to be cautious with studies and reports that have focused on post-settlement disturbance history, like Basquill et al. (2001)

p.6, first 3 sentences

-natural disturbances do not "remove" forests – to the contrary, they tend to leave behind lots of standing and downed live and dead trees

p.6 second paragraph

-"therefore disturbances are necessary for maintaining species richness and biodiversity"

-this is a loaded statement that is not particularly accurate or well-founded

-frequent disturbances, at a large or small scale, can have severe negative impacts on biodiversity, for example repeated high-intensity fires or repeated short rotation clearcutting

p.7, second paragraph

-black spruce is indeed primarily on imperfectly to poorly drained soils, which typically means bogs, forest swamps and other wet areas

-in Nova Scotia, the very nature of these sites, i.e. they are typically *wet* areas, will reduce fire hazard

-also, wet areas are usually in depressions and hollows, and more protected from strong winds than the surrounding landscape

-in all my travels in the woods in this province I have never seen a burned over black spruce swamp with stumps or fire-scarred snags, or a black spruce forest with significant blow down from strong winds

-I suspect the authors are drawing upon information about boreal black spruce forests, which are not easily compared to NS black spruce forests

p.7, section 3.2

-there appears to be a good case for merging 3.2 with 3.3 as they both tend towards uneven-aged stands

p.8, section 3.4

-as this report acknowledges, fire has been a dominant disturbance at least since European settlement, thus distorting post-settlement data on fire frequency and extent.

p.9, second to last paragraph, and section 4.2 (page 18-20)

-interesting there is no mention of the effects of large areas of managed, even-aged, single-species forest on forest insect epidemics – even NSDNR provincial entomologists have warned that simplifying our forests will make them more vulnerable to insect pests

-nor is there mention of studies in NB showing reduced mortality of balsam fir by spruce budworm as hardwood content increases (Su et al. 1996)

-p.19, 2nd paragraph: there are very few, if any, "pure balsam fir ecosystems", even in the Highlands. Balsam fir, black spruce and white birch are all common, as are other species. Even the second paragraph on the same page notes that the 1970s spruce budworm epidemic increased the hardwood cover type from 16% pre-budworm to 36% post-budworm

p.10, first paragraph

-Perkins and Titus Smith both wrote about our forests 200 years post-settlement

-where is the data from the pollen studies mentioned?

p.12, 3rd paragraph

-whether the fire return interval for Mainland Nova Scotia is 900 years or 2,500 years, both estimates suggest that natural fires do not play a major role in regenerating our forests, and that it would be difficult to characterize our forests as regenerated by frequent, stand initiating fire events

p.21, section 4.3

"Stand renewal is initiated after catastrophic wind events such as hurricanes whereby a significant portion of the stand has been destroyed."

-what is meant by a "significant portion of the stand has been destroyed"? As noted above, Hurricane Juan was one of the biggest hurricanes ever seen in Canada, and yet only 5% of the forested portion of the storm swath experienced moderate to severe blow down

p.23, last paragraph

"The risk of blow down in areas partially harvested, silviculturally treated, along the edges of harvested areas, or in riparian zones has always been a management concern, especially on sites where rooting depth is restricted due to shallow soil depth and/or excessive soil moisture."

-what are the authors saying here? It *sounds* like the authors are suggesting that not cutting *everything* is problematic as what is left may be blown down. To reduce risk of blowdown, it would be better to leave fewer hard edges, like those left behind by clearcutting, and to manage for deep-rooted species in wind-prone areas

p.27

The ranking suggests that hurricanes, fire and logging have equal influence in controlling forest structure and composition. On average, 53,000 hectares were clearcut every year over the past 10 years. This amount dwarfs the effects of other disturbances.

p.27

"Thus at any one time in history the majority of the province's forests could have been comprised of uneven-aged climax species or conversely, even-aged forests."

-how does this statement contribute constructively to this discussion?

Table 4

If infrequent stand initiating disturbances lead to even- and uneven-aged conditions, then gap dynamics would be an appropriate natural disturbance regime for the stand types in this category. Red spruce and hemlock, for example, are very shade tolerant, and, as has been seen in some of the remaining pockets of old growth in NS, are sustained by gap dynamics.

p.29, Table 5

It is interesting to note that the numbers have changed since the 2004 version of this report, and that the amount of forest characterized by frequent stand initiating NDRs has increased from 39% to 43%, while the numbers for infrequent stand initiating NDRs and gap dynamics have decreased, from 26% to 24%, and from 30% to 27% respectively. Did new information emerge to allow the authors to go back to the data and reclassify climax forest type?

p.32

"The Royal Commission on Forestry in Nova Scotia (Connor *et al,* 1984) suggested that forests ought to be seen as part of a dynamic environment subject to biological, industrial and social changes. Some of these changes occur consistently, others unpredictably. Nonetheless, they conclude that the impact of human activities on much of the forest is continuous, but, in all but the most extreme cases, nature restores itself and eradicates the traces of man's presence."

-The Royal Commission was not an ecological study, and its conclusions are irrelevant to a scientific paper.

Concluding remarks

There are serious problems with this report, ranging from the use of hyperbole, selective quotes and data, disproportionate attention to fire, insects, and wind storms, and omission of key information and publications. It is clear that this report is fundamentally flawed and that it cannot be used in its current form for the purposes it attempts to fulfill.

References

Bentley, P. A. and E. C. Smith. 1956. The forests of Cape Breton in the seventeenth and eighteenth centuries. Proc. N. S. Instit. Sci. 20:1-15.

Blais, J .R. 1983. Trends in the frequency, extent, and severity of spruce budworm outbreaks in eastern Canada. Can. J. For. Res. 13: 539-547.

Canadian Council of Forest Ministers. 2007. National Forestry Database. Available from http://nfdp.ccfm.org/compendium/data/2006_10/tables/com62e.pdf. Accessed March 21, 2007

Canadian Hurricane Centre. 2007. Available from http://www.atl.ec.gc.ca/weather/hurricane/juan/index.html. Internet accessed March 22, 2007.

Crossland, Donna. 2006. Defining a forest reference condition for Kouchibouguac national park and adjacent landscape in eastern New Brunswick using four reconstructive approaches. MScF. Thesis. University of New Brunswick. December 2006

Green, D. G. 1987. Pollen evidence for the postglacial origins of Nova Scotia's forests. Can. J. Bot. 65:1163-1179.

Lutz, S. G. 1996. Pre-European settlement and present forest composition in King's County, New Brunswick, Canada. MsF Thesis. University of New Brunswick, Fredericton.

Morris, C. 1761. Description and state of the new settlements in Nova Scotia in 1761, by the Chief Surveyor. In: 4-5 Edward VII. Sessional Paper No. 18. A. 1905.

Mosseler, A., Lynds, J., and Major, J. 2003. Old-growth forests of the Acadian Forest Region. Environ. Rev. 11:S47-S77

Mott, R. J. 1975. Palynological studies of lake sediment profiles from southwestern New Brunswick. Can. J. Earth Sci. 12:273-288.

Nova Scotia Department of Natural Resources. 2007. Personal communication (during a telephone conversation) with employee of Forest Inventory Branch. January 17, 2007.

Ponomarenko, E. 2007. Reconstruction of Pre-historical and Early Historical Forest Fires in Kejimkujik National Park and Historic Site, Year One Study. Prepared for Kejimkujik National Park and Historic Site. Ottawa.

Ponomarenko, E. and S. Ponomarenko 2000. Reconstruction of pre-agricultural vegetation pattern in Kouchibouguac National Park using the ecosystem archaeology method. Preliminary Study. Parks Canada, Ecosystem Branch, Gatineau, Que. Unpublished.

Seymour, R.S., Hunter, M.L., Jr., 1999. Principles of ecological forestry. In: Hunter Jr., M.L. (Ed.), Managing Biodiversity in Forest Ecosystems. Cambridge University Press, Cambridge, pp. 22–61.

Su, Q., MacLean, D.A., and Needham, T.D. 1996. The influence of hardwood content on balsam fir defoliation by spruce budworm. *Canadian Journal of Forest Research*. 26: 1620-1628.