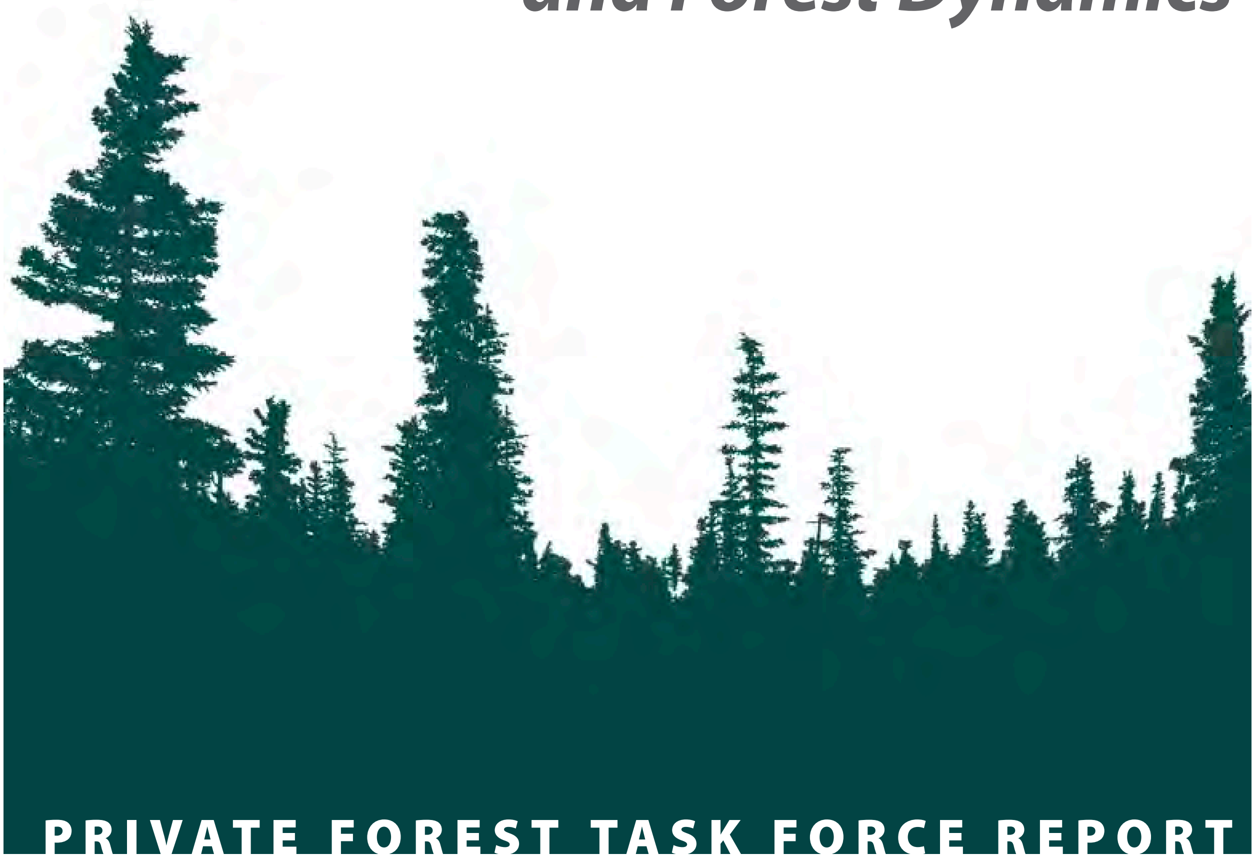
New Brunswick's Private Woodlot Forests

Future Timber Supply Potential and Forest Dynamics



PRIVATE FOREST TASK FORCE REPORT

APPENDIX C

New Brunswick's Private Woodlot Forests: ***Future Timber Supply Potential and Forest Dynamics***

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Introduction

At the request of Dr. Don Floyd, and the Task Force for Private Land Timber Objectives in N.B., the Forest Management Branch of the N.B. Department of Natural Resources (D.N.R.) has conducted a set of wood supply analyses for N.B.'s seven forest products Marketing Boards; which are described in this appendix to the main report.

The intent of this work was to provide an updated view on several of the key features described in Dr. Thom Erdle's (2004) analysis of the private woodlots of N.B. This new analysis was not intended to be as comprehensive as Erdle's earlier study, and related to the mandate of Dr. Floyd's Task Force, we have concentrated the bulk of our effort on key questions related to wood supply. Although this study does make some attempt to describe forest-level predictions for a limited number of coarse environmental indicators, it was not the primary focus. Also important to note is that a large number of alternative future scenarios were considered in the work of the Task Force, a small proportion of which are discussed here.

Throughout this effort, it was the role of D.N.R. to provide the Task Force with technical assistance to aid in their analysis. The direction of the wood supply analysis itself was guided by periodic consultation with Dr. Floyd and his colleagues. This report will attempt to illustrate in a neutral tone, how the private woodlot forests of N.B. respond to ongoing harvest and silviculture activity. Recommendations and value judgements regarding the policies and strategies this sector ought to pursue in the future will come from the Task Force in their primary report.

Landbase Processing

Ownership

The private woodlot forest of N.B. is somewhat difficult to identify. Thousands of persons/families/companies collectively own tens of thousands of properties. The market for these properties is relatively fluid, and transactions are continually splitting / aggregating properties between other woodlot owners and/or industrial interests.

Service N.B. maintains the authoritative property information database listing the registered owner of all real estate in the province. This database was the basis for developing the current extent of the private woodlot forest. Because this database is not maintained with the intent of this particular study, a significant effort was required to identify the set of private woodlot owners. All properties registered to the Crown were removed, and the remaining properties were scrutinized in a manual process to identify where similar, but not identical, listings are likely owned by the same person/family/company.

e.g. *(Doe, John of 123 Wood St. v.s. Doe, J. & Jane of 123 Wood St.)*

Properties were removed from the analysis where they were registered to companies meeting the legal definition of 'Industrial Freehold' given in the *Forest Products Act* as belonging to an entity that operates a wood-processing facility or to an owner collectively holding more than 100,000 ha. Also removed was a large-number of properties which were individually less than 1ha. Making up primarily building lots, this removal improved down-stream processing time and collectively, these properties are expected to be insignificant in terms of forest production.

The remaining parcels were intersected with the active forest inventory database maintained continually at DNR Forest Management Branch. The area of productive forest within each parcel was summarized, and any individual properties with less than 1 ha of tree cover were removed from the analysis (again presuming that most properties falling into this class are small building lots contributing little to the overall private forest landbase). The remaining properties were aggregated by the assigned owner, and owners were classified into 3 size classes:

- 1 – 30 ha of productive forest holdings (regardless of the number of properties)
- 30 – 100 ha of productive forest holdings (regardless of the number of properties)
- 100 + ha of productive forest holdings (regardless of the number of properties)

All properties were assigned to Marketing Boards based on the definitions given in the *Natural Products Act*. The resulting layer would become the working estimate for the extent of NB's private woodlot forest used in the remainder of the analysis.

Land-use Classification

A significant analysis was undertaken to identify and flag areas of biologically productive forest which are permanently unavailable for harvest for reasons related to legislation, geography, competing land-use, or clear owner preference. These areas would remain in the model to account for their non-timber value.

- A network of riparian buffers was generated around all mapped streams / rivers / lakes / wetlands / and shorelines representing the area protected under the *Clean Water Act*
- All forest located on islands within the province's large river systems, lakes, and coastlines (including the large Fundy isles)
- All properties registered to companies clearly identifiable as maple syrup producers
- All properties registered to the Nature Trust of NB and the Nature Conservancy of Canada.

Figure 1: *A map showing the extent of N.B.'s seven forest product Marketing Boards. Coloured areas signify private woodlot forests.*

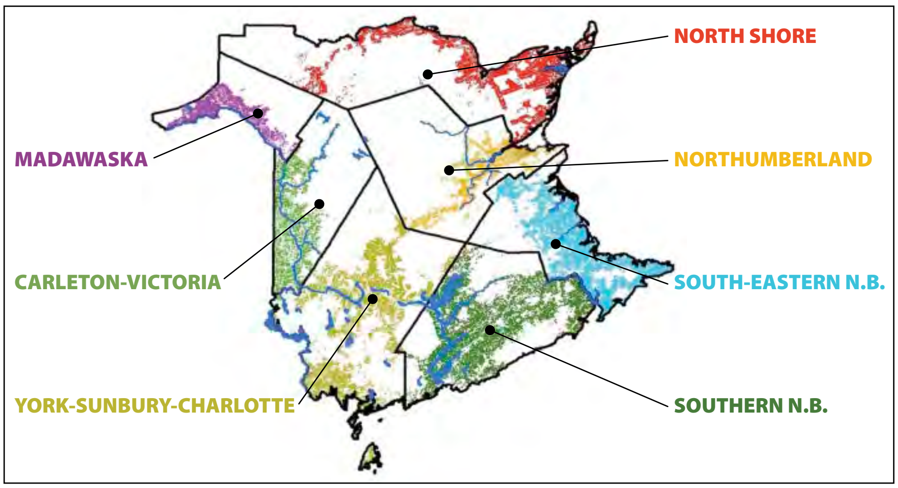


Table 1: *Ownership summary of private woodlot areas by size class and Board for all properties included in this analysis.*

			Productive Forest Area by Size Class			
Marketing Board	**# Properties**	**# Owners**	**1-30 ha**	**30-100 ha**	**100+ ha**	**Total Area**
Carleton-Victoria	9,400	5,100	30,900	65,200	62,000	158,100
Madawaska	5,400	2,800	16,600	41,100	43,300	101,000
North-Shore	21,200	13,800	96,200	71,500	106,700	274,400
Northumberland	7,700	5,200	34,300	42,700	56,700	133,700
South East N.B.	15,400	13,100	91,800	85,100	110,900	287,800
Southern N.B.	10,200	14,300	77,600	183,900	164,700	426,200
York-Sunbury-Charlotte	13,900	12,000	69,000	162,200	127,500	358,700
Provincial Totals	**83,100**	**66,400**	**416,400**	**651,700**	**671,800**	**1,739,900**

Table 2: *Land-use summary of private woodlots included in this analysis by Board.*

	Productive Forest Area by Land-Use					
Marketing Board	**Riparian Buffers**	**Conservation Property**	**Maple Producers**	**Isolated Islands**	**Fibre-Available Forest**	**% Constrained**
Carleton-Victoria	14,100	0	1,200	< 100	142,800	9.7%
Madawaska	8,400	0	800	0	91,800	9.1%
North-Shore	18,300	0	3,500	8,200	244,400	10.9%
Northumberland	9,000	0	0	< 100	124,700	6.7%
South East N.B.	19,400	200	0	400	267,800	6.9%
Southern N.B.	34,000	1,800	0	1,600	388,900	8.8%
York-Sunbury-Charlotte	25,600	600	< 100	14,000	318,600	11.2%
Provincial Totals	**128,800**	**2,600**	**5,500**	**24,200**	**1,579,000**	**9.2%**

Forest Inventory

Within the zone delineated from the ownership analysis, DNR's provincial forest inventory was prepared for the modelling effort. A recent analysis of Crown forest wood supply provided a framework for which to describe the forest. Stands were classified into five broad categories on the basis of intervention history:

- plantations
- pre-commercial thinnings
- young, post-harvest natural regeneration
- partial harvests
- unmanaged mature forest

These groups were subdivided into a number of strata on the basis of species composition, stand structure, and broad age class. Stands were assigned ages where inventory records were absent to reflect the distribution known to occur across private woodlots from recent Forest Development Survey (FDS) records.

The forest inventory acquisition schedule is such that the information for a geographic region may be as much as 10 years out-of-date. This presents a challenge for initializing a wood supply model with a correct estimate of growing stock and harvestable area. Unlike Crown lands, harvests on private woodlots are not spatially monitored and there is no regular process to annually update the inventory. As such, a significant effort was undertaken to update for recent harvest.

Updating for Recent Harvest

Data outlining harvest estimates for the years 2000-2010 was collected from the Utilization section of DNR Forest Management Branch, the Marketing Boards, and from the NB Forest Products Commission. DNR data tracks wood consumed at mills by their Marketing Board of origin. Its strength is in the relatively small number of people/organizations contributing to the estimates however it isn't able to account for raw log export. The Marketing Board data is an annual production summary of all wood produced within their limits which was subject to levy. The NB Forest Products Commission data addresses exports by tracking all wood moving throughout the province with the Transportation Certificate system, however the large volume of forms and limited oversight available suggest that data quality is potentially an issue. The solution was to combine these independent sources and treat the greatest of the three estimates for any given product in any given year as the authoritative figure.

Figure 2: *Results from three independent data sources showing estimates for Sp/Bf/Jp volume harvest (all products) occurring within the Southern N.B. Marketing Board area from 1997-2010. Similar estimates were generated for all Boards and major species groups.*

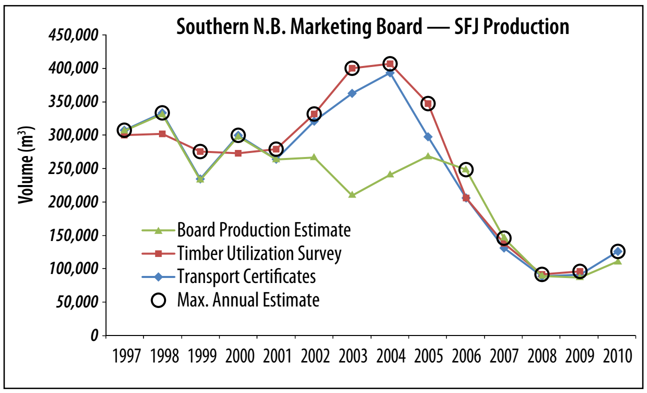
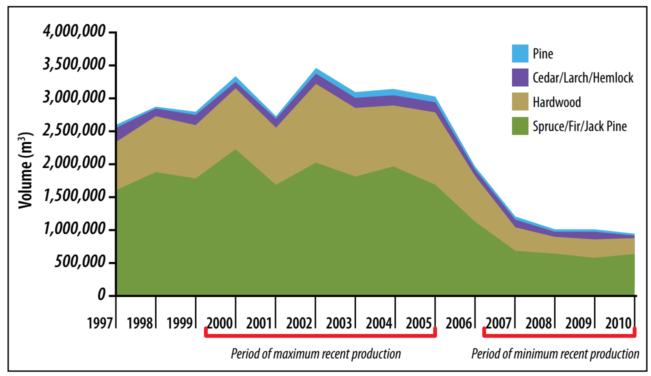


Figure 3: *Total production estimate by species for all Boards combined for the 1997-2010 period. This figure produced using the methodology described above. Of note is the sharp harvest decline beginning in 2006.*



The annual harvest estimate for each Board was prorated geographically to aerial photography blocks to account for inventory vintage. Within each combination of Marketing Board and photo-block, a simplified model was used to determine the area of mature, harvest-eligible forest that would be required to remove the correct volume in approximately the known ratios of spruce/fir, hardwood, and other softwood products. This simplified update model assumed that harvest occurred randomly across the landscape of eligible strata, and that clearcutting accounted for 90% of the volume removal. Areas were reclassified as natural regeneration in the simulated harvest strata, and the remaining forest was aged forward to 2012, the initialization date of the primary analysis.

Updating for Recent Silviculture

Properly reflecting the area treated with silviculture is a significant concern for wood supply modelling and presented an additional challenge to this analysis. As with harvest area, the silviculture on any given area can be as much as 10 years out-of-date due to the inventory cycle. Compounding this issue is that photo-interpretation of silviculture areas on private woodlots can be particularly difficult; leaving many existing areas missed in the forest inventory.

DNR FMB receives certification reports from all private woodlot silviculture blocks which are reimbursed by the Province. These certification forms date back to the late 1970's and represent the best approximation of the actual area annually planted and thinned. The area was referenced against the forest inventory and the deficiency in recent years was calculated. It was assumed for the sake of this analysis that any thinnings more recent than 1992 and any plantings post

1982 would still be present. Older silviculture areas could have been harvested (and thus already represented correctly in the inventory) so they were only kept in the wood supply model where clearly identified in the regular inventory.

Figure 4: *A 30 year history of pre-commercial thinning activity by Board as indicated by reimbursement records kept within DNR.*

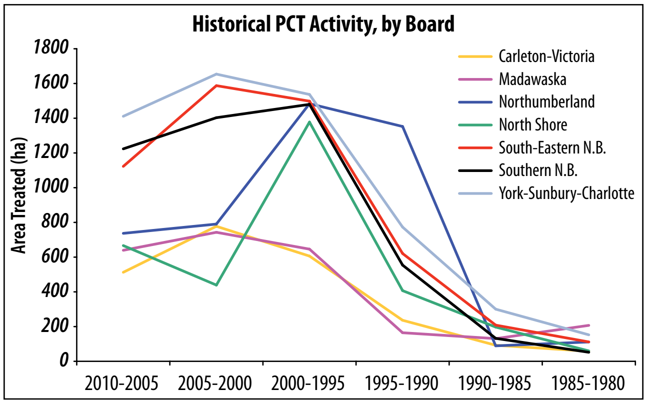
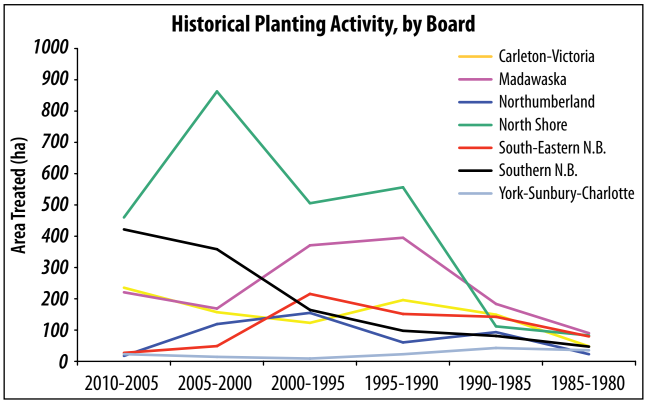


Figure 5: *A 30 year planting history by Board as indicated by reimbursement records kept within DNR.*



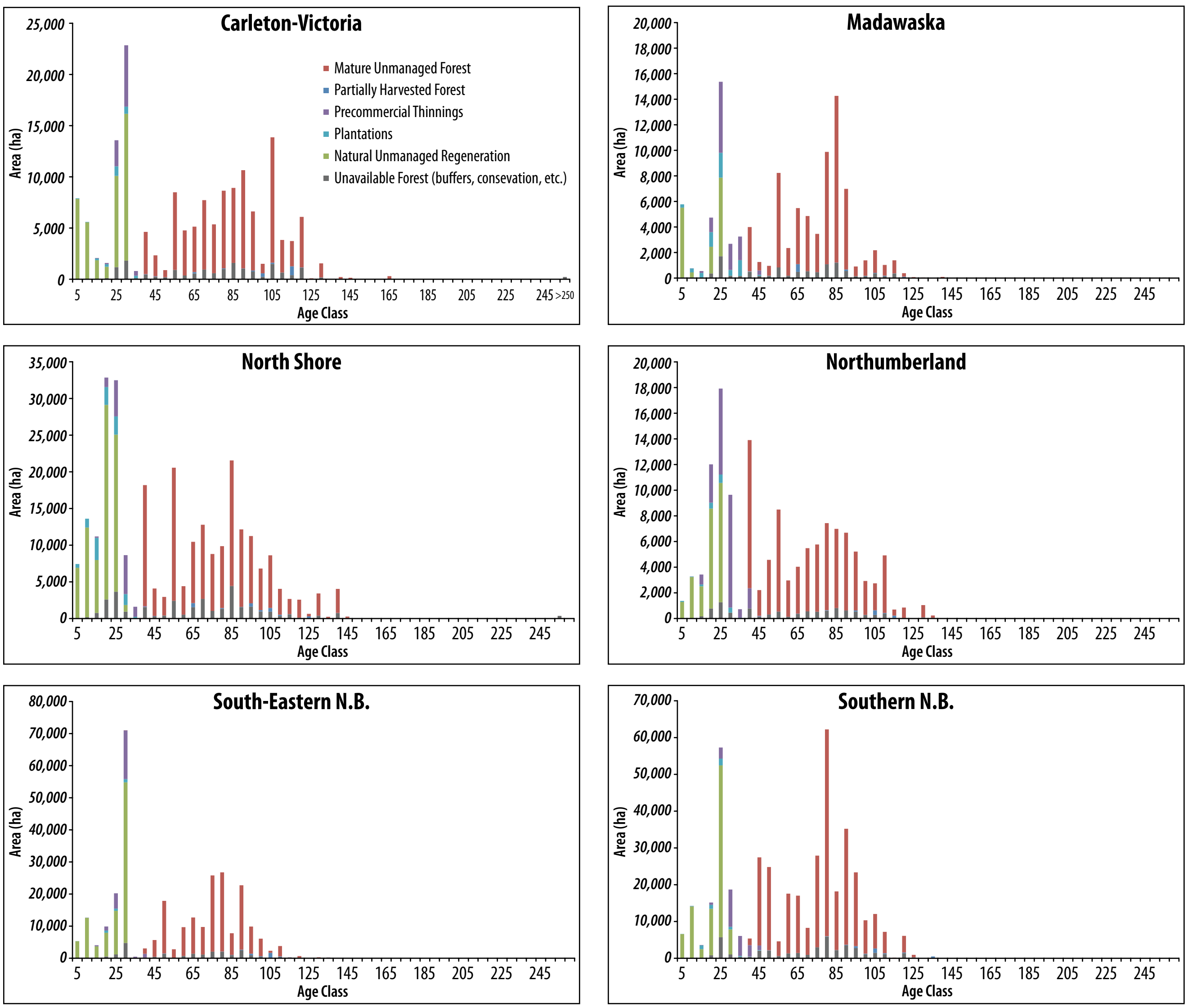
For the past 5 years, several Marketing Boards have been providing DNR with GPS maps of silviculture activities. Those data were used as the preferred means to update the forest inventory for missing silviculture areas over that time period. However, the vast majority of the missing area was updated by randomly reclassifying naturally regenerating post-harvest stands in 'cutover', 'regenerating', and 'young' age categories into plantings and thinnings. Simulated plantings were assigned to crop species to match the distribution of the certification forms. A similar method was used to assign thinnings to softwood, mixedwood, and hardwood types. Stand ages were adjusted such that the 2012 forest inventory on each Marketing Board reflects the treatment history in the certification forms.

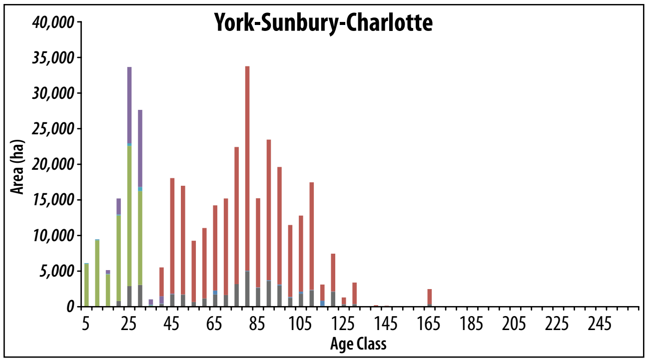
Today's Forest Structure

Age Class Distribution

The resultant forest inventory for each Board is summarized below in terms of the projected age class distribution as of 2012. The initial age class distribution reveals characteristics of each Board's disturbance history, and provides some insight to future wood quality expectations.

Figure 6: *Initial age class distribution estimates for each Board showing area (ha) in 5-year classes.*



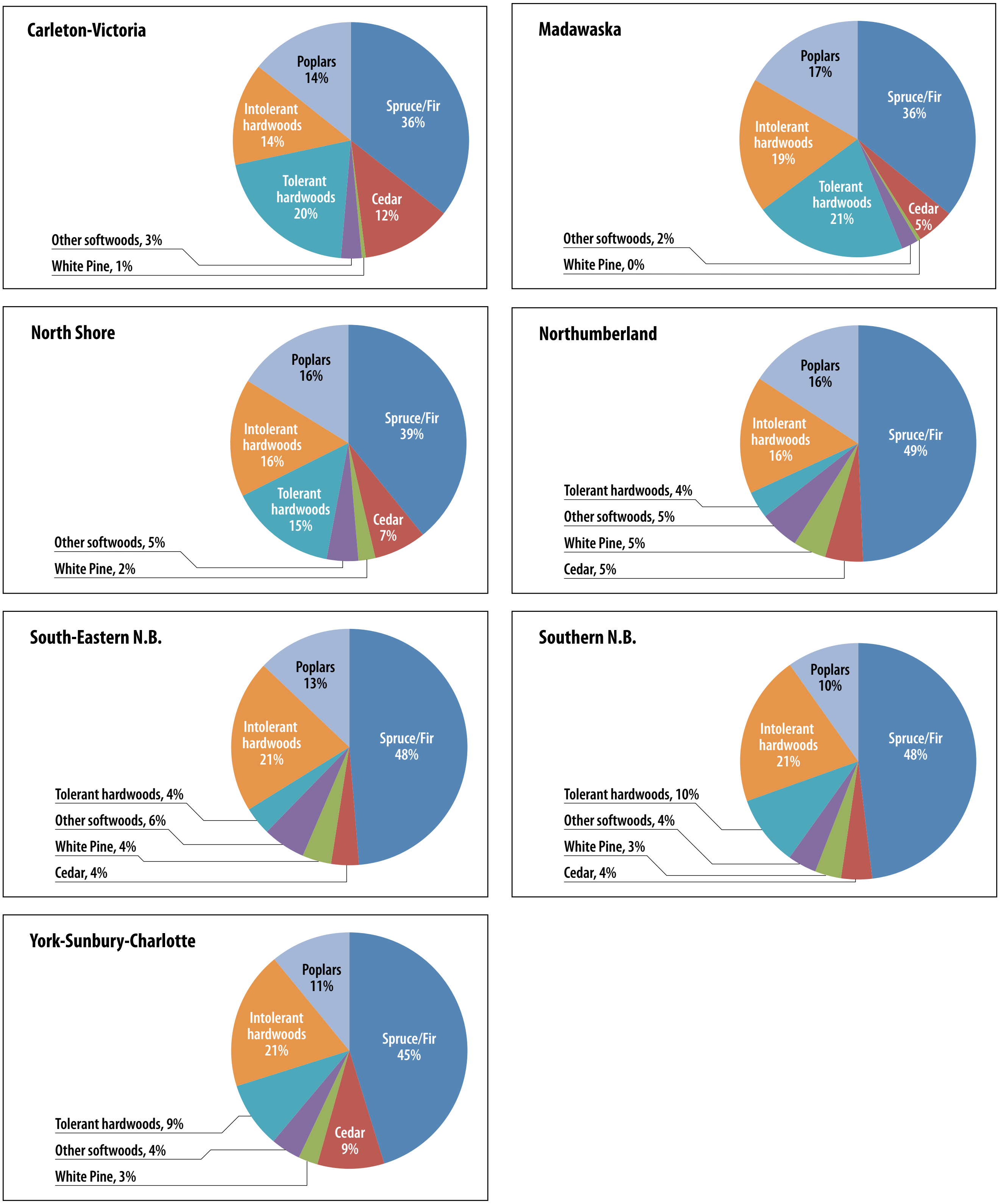


In general, all Marketing Boards have available a significant area of mature forest. The pattern of ages captured in areas unavailable for harvest (islands, riparian buffers, etc.) tends to be concentrated in the older classes. Across all Boards the age structure is erratic in adjacent younger age classes, which would tend to suggest large swings in harvest areas in recent decades. The Boards tend to have large areas in the 25-30 year old age classes, and a much reduced area in the 0-20 year old class. This pattern is contrary to expectations. Rather, it is more likely that it illustrates some artefact in the inventory aging process used within DNR and modified in data preparation. The imbalance in younger age classes is likely a consequence of both field aging procedures where advanced natural regeneration is present after harvest and the lack of a spatial GIS data-capture system for woodlot harvest area. It's advisable that this age-imbalance issue be investigated more fully in any management scenario that capitalizes on precise harvest timing across woodlots (which is not the case in this analysis).

Species Composition

The inventory is reflective of some broad differences in the composition of the Boards, which in itself reflects the climatic and site variability within the province. The Boards in the north and west including Carleton-Victoria, Madawaska, and the North-Shore have the highest concentrations of hardwoods and specifically shade-tolerant species. Conversely, these Boards tend to have the lowest softwood composition. The softwood composition across all Boards is dominated by spruce/fir although Carleton-Victoria and York-Sunbury-Charlotte both have notable cedar content. White pine is distributed in minor amounts throughout the Boards however is virtually absent in Carleton-Victoria and Madawaska.

Figure 7: *Initial species composition shown by merchantable volume standing in the forest inventory as of 2012 by Board.*



Growth & Yield Forecasting

For the purpose of wood supply modelling and forest inventory projection, we must be able to forecast the natural development and treatment response of each stratum. In this analysis, we make that forecast in terms of a tree's volume development and potential for solid wood products.

The NB Growth & Yield Unit maintains the technology, data, and experience to produce the stand forecasts needed for this analysis. A database was compiled from all FDS data collected on private woodlots within NB. This data was forecasted forward using STAMAN, the individual-tree model employed by the Province for similar Crown land analyses. Tree-level growth, mortality, and stand-level ingrowth is predicted in 5-year cycles on the basis of site quality, stand structure, and species composition. The resulting individual stand forecasts were aggregated to strata using the same scheme applied to the forest inventory. Individual tree volumes were analysed for their potential wood products using a recently calibrated taper model for NB species.

In very general terms, the forest's potential for wood supply is related to the standing inventory in the mature stands eligible for immediate harvest, and the speed at which the forest regenerates following harvest. A considerable variability exists among Marketing Boards in terms of standing yield, composition, and forecasted productivity. This variability owes to a multitude of factors but is generally reflective of each Board's history of recent harvest practices, climate, and inherent soil/site characteristics.

Table 3: *Area, standing yield, and composition of the mature, unmanaged forest as of 2012. Averages shown by cover type and Marketing Board. "Log-Potential" volume defined as having dimensional characteristics (length, taper, top diameter) with potential for solid wood-products.*

Board	Cover Type	Average Yield (m3/ha)	Proportion of the Average Yield (%)							
			Sp/Bf/Jp	White Pine	Cedar	Other Sw	Tol. Hw	Intol. Hw	Poplar	Log-Pot. (All Species)
Carleton-Victoria	Hardwood	132.5	14.1%	0.1%	1.1%	1.2%	53.9%	13.3%	16.4%	53.9%
	Mixedwood	124.6	36.8%	0.6%	8.0%	2.4%	14.0%	18.0%	20.1%	57.1%
	Softwood	148.5	39.4%	0.8%	35.2%	5.9%	3.9%	7.5%	7.4%	74.1%
	All	133	30.5%	0.5%	13.4%	3.0%	23.5%	13.6%	15.4%	60.8%
Madawaska	Hardwood	128	16.8%	0.1%	1.5%	0.4%	37.6%	22.9%	20.8%	50.8%
	Mixedwood	114.9	38.5%	0.6%	6.0%	1.7%	12.4%	20.0%	20.9%	55.2%
	Softwood	133.7	57.1%	0.9%	14.0%	7.1%	3.1%	8.6%	9.2%	69.8%
	All	124.8	30.9%	0.4%	5.2%	2.0%	23.6%	19.3%	18.6%	55.7%
North Shore	Hardwood	128.9	14.9%	0.7%	1.7%	0.2%	34.6%	17.8%	30.2%	48.2%
	Mixedwood	126.5	41.0%	1.4%	5.5%	3.0%	10.7%	21.6%	16.9%	58.5%
	Softwood	124.6	57.4%	4.4%	17.2%	5.4%	2.1%	8.9%	4.7%	65.8%
	All	126.7	37.5%	2.1%	8.0%	2.8%	16.0%	16.2%	17.4%	57.4%
Northumberland	Hardwood	135.2	15.4%	2.2%	0.2%	0.3%	8.4%	13.9%	59.6%	42.9%
	Mixedwood	121.3	39.5%	2.5%	3.1%	3.2%	7.8%	24.8%	19.2%	55.7%
	Softwood	118.8	61.8%	6.1%	9.5%	5.2%	2.1%	10.6%	4.7%	63.1%
	All	121.7	47.3%	4.2%	5.8%	3.8%	5.1%	16.5%	17.3%	57.7%
South-Eastern NB	Hardwood	129	20.8%	1.7%	0.7%	0.7%	12.6%	28.4%	35.1%	49.3%
	Mixedwood	118.7	39.1%	2.6%	2.8%	2.8%	7.8%	28.5%	16.6%	53.2%
	Softwood	115.4	63.6%	4.6%	7.0%	7.3%	2.6%	10.8%	4.2%	63.9%
	All	118.3	47.0%	3.3%	4.3%	4.4%	6.2%	21.5%	13.5%	57.1%
Southern NB	Hardwood	130.4	17.3%	0.8%	0.5%	0.5%	44.8%	24.3%	11.7%	52.1%
	Mixedwood	116	39.1%	2.7%	3.0%	2.2%	9.3%	29.0%	14.8%	52.6%
	Softwood	123	65.2%	4.3%	7.7%	4.7%	2.9%	11.2%	4.0%	64.5%
	All	120.8	46.3%	3.0%	4.5%	2.9%	12.1%	21.2%	10.0%	57.3%
York-Sunbury-Charlotte	Hardwood	126.2	17.2%	0.4%	1.1%	1.1%	44.8%	21.3%	14.1%	51.8%
	Mixedwood	119.3	38.7%	1.9%	5.6%	2.8%	10.8%	25.3%	14.9%	55.1%
	Softwood	128.5	54.0%	3.5%	17.3%	6.0%	3.2%	11.3%	4.8%	67.1%
	All	123.6	42.5%	2.4%	9.8%	3.9%	11.6%	19.2%	10.7%	59.6%

Table 4: *Expected yield and composition at age 50 of unmanaged post-harvest regeneration, pre-commercial thinnings, and plantations. These averages are reflective of the varying site quality between Boards and are meant to characterize broad response to management conducted in each Marketing Board today.*

Board	Cover Type	Average Yield (m3/ha)	Proportion of the Average Yield (%)							
			Sp/Bf Jp	White Pine	Cedar	Other Sw	Tol. Hw	Intol. Hw	Poplar	Log-Pot. (All Species)
Carleton-Victoria	Unmanaged Regeneration	107.3	38.6%	3.8%	0.9%	4.0%	11.0%	18.5%	23.1%	34.3%
	Plantation	270.4	98.2%	0.6%	0.0%	0.3%	0.0%	0.3%	0.6%	86.5%
	Pre-commercial Thinning	159.7	43.3%	1.7%	1.6%	0.1%	8.1%	31.9%	13.4%	41.3%
Madawaska	Unmanaged Regeneration	106.8	38.7%	3.7%	1.9%	1.7%	7.6%	16.9%	29.5%	33.4%
	Plantation	257.2	97.9%	0.7%	0.0%	0.4%	0.0%	0.4%	0.6%	84.7%
	Pre-commercial Thinning	159.6	43.9%	1.0%	1.0%	0.1%	7.2%	22.1%	24.7%	38.2%
North Shore	Unmanaged Regeneration	105.7	35.9%	2.6%	1.3%	1.0%	8.7%	17.9%	32.7%	33.1%
	Plantation	173.6	86.2%	7.9%	0.0%	3.1%	0.1%	1.5%	1.1%	65.3%
	Pre-commercial Thinning	157.8	46.9%	1.3%	1.3%	0.2%	7.6%	29.5%	13.1%	42.2%
Northumberland	Unmanaged Regeneration	105.9	43.2%	4.8%	1.0%	3.3%	2.8%	13.8%	31.3%	33.5%
	Plantation	163.9	89.3%	3.7%	0.0%	4.0%	0.1%	1.6%	1.3%	62.1%
	Pre-commercial Thinning	152.4	70.5%	4.1%	0.7%	1.0%	3.3%	13.3%	7.1%	51.5%
South-Eastern NB	Unmanaged Regeneration	101.8	44.7%	4.3%	0.7%	4.4%	4.5%	18.3%	23.2%	33.4%
	Plantation	174.9	91.6%	4.1%	0.1%	1.8%	0.1%	1.4%	1.0%	66.0%
	Pre-commercial Thinning	157.1	40.3%	1.4%	0.4%	0.2%	4.6%	18.4%	34.9%	33.0%
Southern NB	Unmanaged Regeneration	102.1	41.3%	6.0%	0.7%	4.3%	7.0%	21.3%	19.5%	31.4%
	Plantation	245.1	96.4%	1.5%	0.0%	0.8%	0.1%	0.5%	0.7%	82.6%
	Pre-commercial Thinning	154.0	48.8%	2.7%	1.8%	0.3%	7.5%	23.8%	15.1%	43.0%
York-Sunbury-Charlotte	Unmanaged Regeneration	106.0	47.7%	6.5%	1.9%	4.4%	4.7%	16.7%	18.2%	35.7%
	Plantation	197.0	92.9%	3.8%	0.0%	1.1%	0.1%	1.1%	1.0%	72.7%
	Pre-commercial Thinning	156.4	52.0%	2.1%	1.0%	0.4%	5.7%	23.4%	15.5%	42.7%

Table 5: *Dimensional characteristics of forest products tracked within the wood supply model. Reference to "Log Potential" product types appears elsewhere in this report.*

Product	Min. Top Diameter (cm OB)	Length(s)	Log Potential
Spruce/Fir/Jack Pine			
Pulp	8	<= 8′	No
Stud	12	8′ - 9′	Yes
Sawlog	18	8′ - 16′	Yes
Oversize Log	40	12′ - 16′	Yes
White Pine			
Pulp	8	<= 8′	No
Sawlog	18	10′ - 16′	Yes
Veneer	26	8′	Yes
Cedar			
Pulp	8	<= 8′	No
Saw/Fencing	12	6′ - 10′	Yes
Saw/Shingles	20	6′ - 10′	Yes
Hardwood			
Pulp	8	<= 8′	No
Sawlog	20	8′ - 12′	Yes
Large Sawlog	24	14′ - 16′	Yes
Veneer	26	8′ - 12′	Yes

Wood Supply Model Construction

The software used for the wood supply analysis was Remsoft's Woodstock. Woodstock is capable of both forest inventory projection simulation and harvest schedule optimization. Woodstock is also capable of stochastic, Monte-Carlo type simulation which has been used successfully in the previous Erdle study to assess private woodlot wood supply. For these analyses, the user inputs desired annual levels of harvest and silviculture treatments which the model randomly applies to the landscape in eligible forest types. Inventory is projected forward, and stands subjected to treatments are reclassified accordingly. For this analysis, the following actions were available for consideration:

Table 6: *Harvest treatment and silviculture options as they are represented in the private woodlot wood supply model. Note that some degree of operational simplification is necessary to facilitate forecasting. These options are meant to broadly characterize the average harvesting types at play today, and are by no means intended as a comprehensive suite of options available to the woodlot manager designing treatments on the ground.*

Treatment Type	Description	Objectives	Residual Target Conditions	Eligibility	Operability	Removal Rate (%)	Pecking Order for Removal
Clearcut	harvesting of all merchantable stems	volume production; prepare site for planting and/or protect existing regeneration	suited for site preparation and planting	All forest types	NAT(IMO)- All Eligible NAT (REG and Y)- Age 40 PLT/PCT – Age 35	100	N/A
Shelterwood	partial harvest of merchantable overstory distributed uniformly, or in patches or strips	volume production; promote the establishment of desirable natural regeneration	5% permanent retention; meets residual basal area targets by species group; seedbed suitable for natural regeneration of desired species	Natural stands dominated by species that regenerate poorly in clearcuts.	TOHW-sM, >18m2/ha	35	non-KTS outside trails
					TOHW-yB, >18m2/ha	40	non-KTS outside trails
					TOSW, >18m2/ha	30	non-KTS outside trails
					PINE, >10m2/ha or KTS >20m2/ha	40	non-KTS outside trails
					RS, >18m2/ha	30	non-KTS outside trails
Strip/Patch	systematic partial harvest of merchantable overstory distributed in patches or strips	volume production; promote the establishment of desirable natural regeneration	meets area removal target; seedbed suitable for natural regeneration of desired species	All forest types	NAT(IMO)- All Eligible NAT (REG and Y)- Age 65 (Re-entry at 10 years)	33	None
				All forest types	NAT(IMO)- All Eligible NAT (REG and Y)- Age 65 (Re-entry at 10 years)	50	None
Selection	partial harvest of merchantable stems distributed uniformly or in groups with relatively longer re-entry periods	volume production; create/maintain multi-aged stand & mature overstory; regenerate KTS species; improve stand growth/quality	meets residual basal area or area removal target, seedbed suitable for natural regeneration of desired species in harvested gaps	Natural stands with >50% KTS and meet quality tree and stand criteria	>26 m2/ha (Re-entry at 20-30 years)	30	non-KTS outside trails; minimum # of quality stems
Planting	Planting of pure species and species mixtures	Full site utilization by planted desired species	Density of 2000 trees/ha planted in rows of desired spacing.	Clearcut	Function of site/species	n/a	n/a
Pre-commercial Thinning (SW)	softwood spacing in naturally regenerating stands	reduce inter-tree competition; focus growth on desired species	>50% post-stocking to SW; Density of 2000-3500 trees/ha dependent upon species	Clearcut, Shelterwood, Strip/Patch	NATREGY (age 10-20), SW or MW	n/a	n/a
Pre-commercial Thinning (HW)	hardwood spacing in naturally regenerating stands	reduce inter-tree competition; focus growth on desired species	> 50 % post-stocking to HW; Density of 3000-3500 trees/ha for TH Density of 2000-3500 trees/ha dependent upon species	Clearcut, Shelterwood, Strip/Patch	NATREGY (age 10-20), HW or MW	n/a	n/a

KTS = Key Long-Lived & Late Successional Tree Species (rS, eH, eC, wP, rP, sM, yB, Be, Ash, Oak)

Each harvest treatment option in the wood supply model elicits a response from the forest. In general terms, clearcut harvesting was assumed to greatly increase the component of balsam fir and intolerant hardwoods in the regenerating forest at the expense of long-lived or shade tolerant Acadian tree species (defined above). In non-clearcut type treatments, the regeneration of these characteristic Acadian species was assumed to increase with decreased harvest intensity, and with increased abundance in the pre-harvest overstory. In addition to favourable regeneration patterns, uneven-aged selection harvests generally increased the long-term production of saw-potential material. The suite of non-clearcut treatments considered was assumed to contribute approximately 10% of the ongoing wood supply based on discussions with Marketing Board staff and representatives from the NB Federation of Woodlot Owners.

One of the largest drivers of forest-level wood supply is the ability to target harvest scheduling. In general, overall production increases with the ability to harvest stands approaching their time of maximum mean annual increment (MAI), and to avoid harvest in rapidly growing, immature conditions.

Linear optimization modelling techniques are the standard for most large-scale wood supply analysis. These models are able to show the maximum potential wood supply of a large scale landbase in the face of complex harvest constraints. In real-world application, the challenge is often in implementing the required harvest schedule due to limitations in forest inventory, and challenges in creating profitably sized harvest patches. The key to achieving the high harvest output from these optimization models is being able to exercise very precise control over the forest in question.

There is both reason and evidence to challenge the use of optimization techniques on a forest comprised of thousands of independent owners. There is no regulatory vehicle in NB which grants any central body power over the decisions woodlot owners make on their lands. Centralized organization over large scales (10,000 ha – 100,000 ha) would have to be voluntary in nature and difficult to coordinate (although several attempts have been made in recent history). Rather, harvest decisions are largely influenced by personal pressures (such as a financial need). That said, there is evidence that the wood flow from private forests responds predictably over large scales to stimuli such as delivered wood prices and tax incentives. Even within a given ownership there is considerable evidence to suggest that most harvest isn't scheduled for long-term regular flow. In many cases, entire properties are harvested in a short period of time of merchantable timber.

Figure 8: *An aerial photograph selected from the provincial forest inventory showing the typical pattern of private woodlot harvesting that occurs frequently on small holdings in N.B. This pattern approximates a random selection of eligible stand types of merchantable ages.*

This practice is contrary to the stand-by-stand harvest scheduling which drives optimization models. That said, a Monte-Carlo simulation approach is well suited to reflect the reality of a diverse, private forest. This approach to harvest scheduling makes the assumption that forest conditions are harvested in proportion to their overall abundance on the landscape. The user controls the overall harvest level on a given area and the simulation forecasts the mix of resulting species, products, the harvest's ability to sustain itself perpetually, and the impact to various forest characteristics. Because individual strata are randomly drawn for harvest at any given time, no two simulations are identical. To that end, the approach for this analysis is to report the average outcomes of 5 independent simulations for each harvest scenario.

This analysis has explored a number of simulations on each Marketing Board area testing harvest sensitivity to scheduling, silviculture inputs, and examining the sustainability of recent harvest rates. It is important to note that where scenario results are described in terms of provincial totals, they are summations of simulations made independently on the 7 Marketing Board areas.

Scenario Preparation

The model of landscape-level sustainability which is typically used to describe vast forested areas such as Crown lands is somewhat difficult to extrapolate to private woodlot holdings. What is a sustainable harvest rate? What forest health indicators ought to be considered in making this judgement? What does this forest-level sustainability look like on an individual woodlot?

In its most primitive form, a sustainable harvest rate could be defined as that which the biological growth processes of the forest can maintain in perpetuity. This is the harvest rate at which any additional volume removal would cause the supply to collapse at some point in the future. Maintaining harvest flow for prolonged periods at this maximum theoretical rate is certain to have a detrimental impact to both the quality characteristics of the harvest, and to the health of the forest. Through an iterative process, testing varying harvest pressures, it is possible to zero-in on this theoretical harvest limit for each Board. It is then worthwhile to simulate how scaling back from this maximum harvest pressure can serve to produce a positive impact on indicators of harvest quality and forest health.

For this set of analyses, we present a maximum theoretical harvest rate (total volume) for each Board, and simulations which relieve this pressure in 10% increments to a 70% minimum. We also include additional simulations which forecast the impacts of continuing harvest at the recent period of provincial maximum production (2000-2005), and more recently the period of industry downturn (2007-2010). For all simulations in this set, we assume that the average silviculture inputs from the 5 years prior to this analysis (2005-2010) will continue indefinitely.

Table 7: *Annual volume targets by Board which serve as the input to the wood supply model representing a broad range of historical and theoretical harvest pressures.*

Board	Maximum Theoretical Rate	90% of Max.	80% of Max	70% of Max	2000-2005 Harvest (% of Max)		2007-2010 Harvest (% of Max)	
Carleton-Victoria	385,000	345,000	308,000	270,000	310,000	(80.5%)	214,000	(55.6%)
Madawaska	265,000	239,000	212,000	186,000	256,000	(96.6%)	136,000	(51.3%)
North-Shore	645,000	581,000	516,000	452,000	786,000	(121.9%)	202,000	(31.3%)
Northumberland	345,000	311,000	276,000	241,000	304,000	(88.1%)	36,000	(10.4%)
South-Eastern N.B.	700,000	630,000	560,000	490,000	404,000	(57.7%)	124,000	(17.7%)
Southern N.B.	1,030,000	927,000	824,000	721,000	550,000	(53.4%)	160,000	(15.5%)
York-Sunbury-Charlotte	855,000	770,000	684,000	599,000	500,000	(58.5%)	168,000	(19.6%)
Total	4,225,000	3,803,000	3,380,000	2,958,000	3,110,000	(73.6%)	1,040,000	(24.6%)

Table 8: *Average annual silviculture levels (ha/year) by Board which are represented in wood supply models as 'status quo' input levels. These 'recent' treatment levels were developed by averaging observations between 2005-2010. Combined treated area also shown as a proportion of the estimated area clearcut in recent years.*

		Pre-commercial Thinning				% of Annual Cutover Area	
Board	Planting	Increase Softwood	Maintain Composition	Increase Hardwood	Total	(2000-2005)	(2007-2010)
Carleton-Victoria	220	105	370	55	530	35.6%	52.8%
Madawaska	200	125	315	65	505	36.9%	74.9%
North-Shore	570	125	430	60	615	21.1%	87.0%
Northumberland	45	150	520	75	745	35.3%	311.3%
South-Eastern N.B.	35	235	820	115	1,170	37.9%	131.7%
Southern N.B.	445	245	855	120	1,220	41.1%	143.6%
York-Sunbury-Charlotte	20	285	995	140	1,420	41.1%	122.2%
Total	1,535	1,270	4,305	630	6,205	34.3%	107.0%

To enable a holistic view of each harvest scenario and its predicted impact to future forest structure, we'll present the following indicators:

- **Sp/Bf/Jp harvest volume** – predicted supply over time both in total volume and in log-potential volume
- **Hw harvest volume** – predicted supply over time both in total volume and in log-potential volume of all combined commercial hardwood species
- **Piece size** – the predicted average net merchantable volume per tree for trees captured in annual harvest
- **Operable log-potential growing stock (Sp/Bf/Jp & Hw)** – the volume of available timber of log-potential size standing in the forest within stands that are of sufficient age/condition to allow for commercial harvest
- **Area of old forest** – the area of mature forest meeting the general structural standard recognized by the Erdle (2008) Task Force on Forest Diversity & Wood Supply
- **Area of 'Old Forest Wildlife Habitats'** – the area meeting the specific structural attributes identified by D.N.R. related to maintaining key old-forest dependant vertebrate species. ** Note it is important to consider that the modelling framework employed in this study does not support spatial analyses; therefore, patch-size requirements for old forest wildlife habitats cannot be considered. Spatially suitable areas would be significantly reduced from figures reported here.*

Figure 9: *Projected wood quality and forest structure indicators for the Carleton-Victoria Marketing Board following six alternative future harvest rates.*

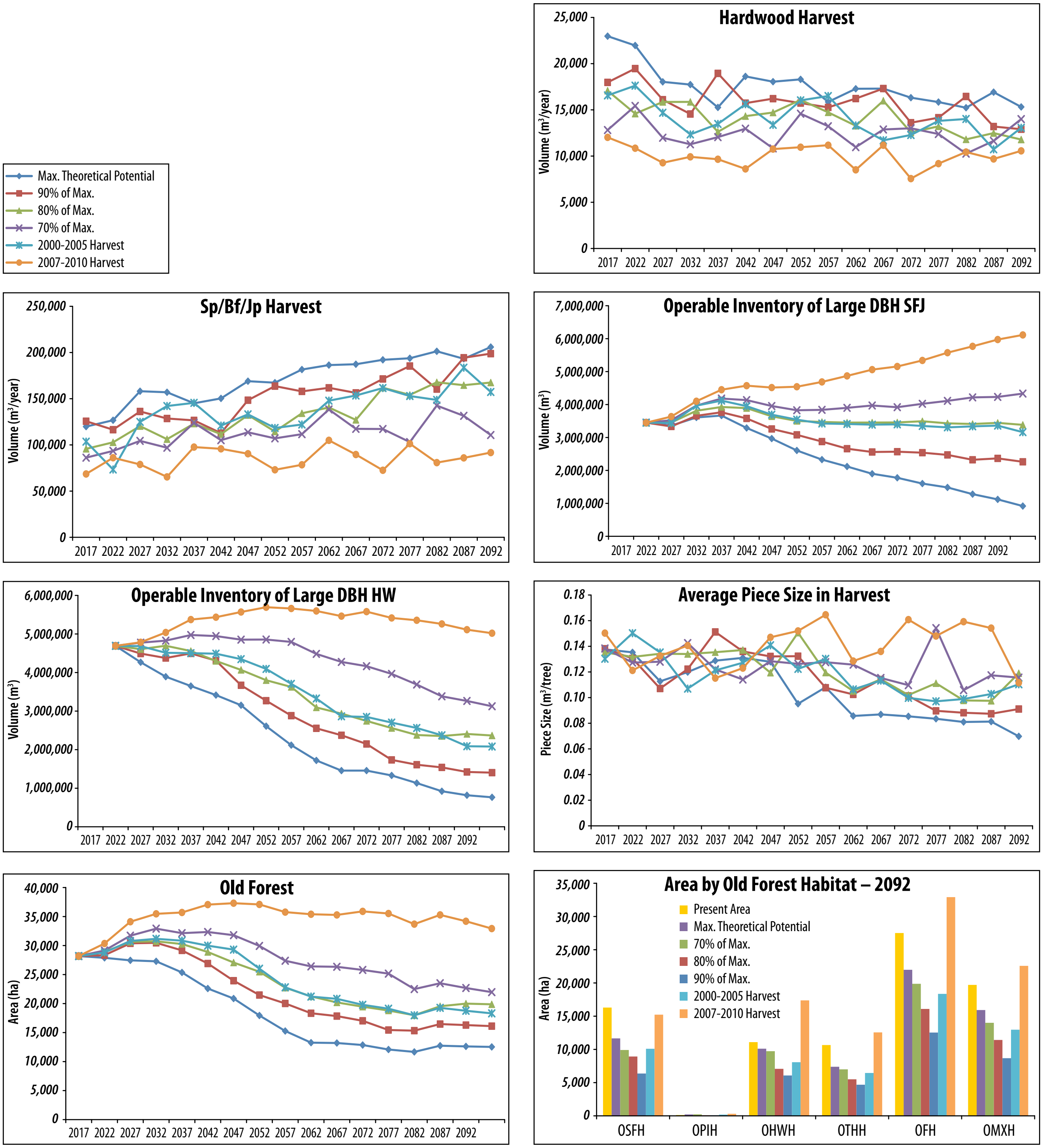


Figure 10: *Projected wood quality and forest structure indicators for the Madawaska Marketing Board following six alternative future harvest rates.*

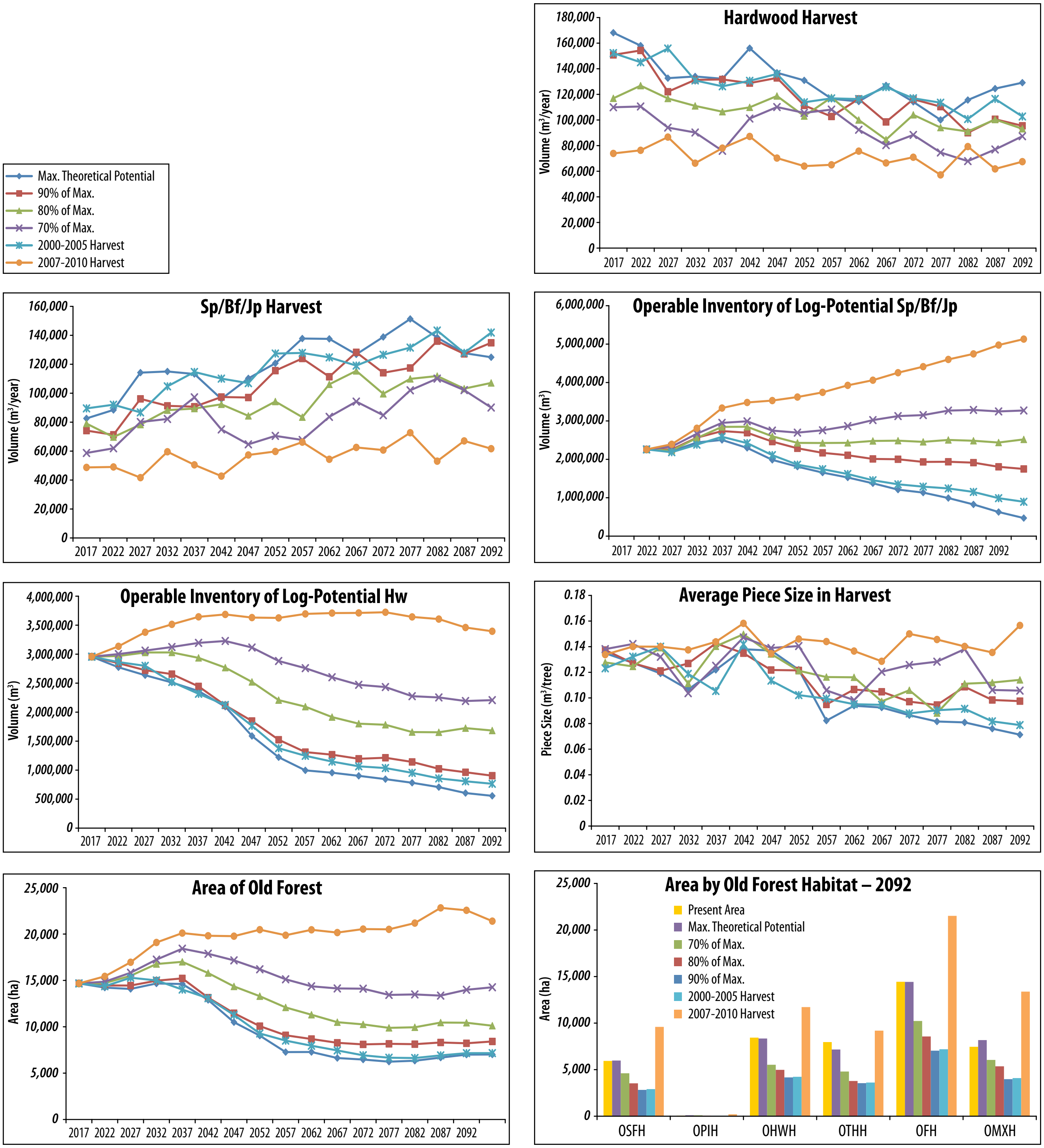


Figure 11: *Projected wood quality and forest structure indicators for the North-Shore Marketing Board following six alternative future harvest rates.*

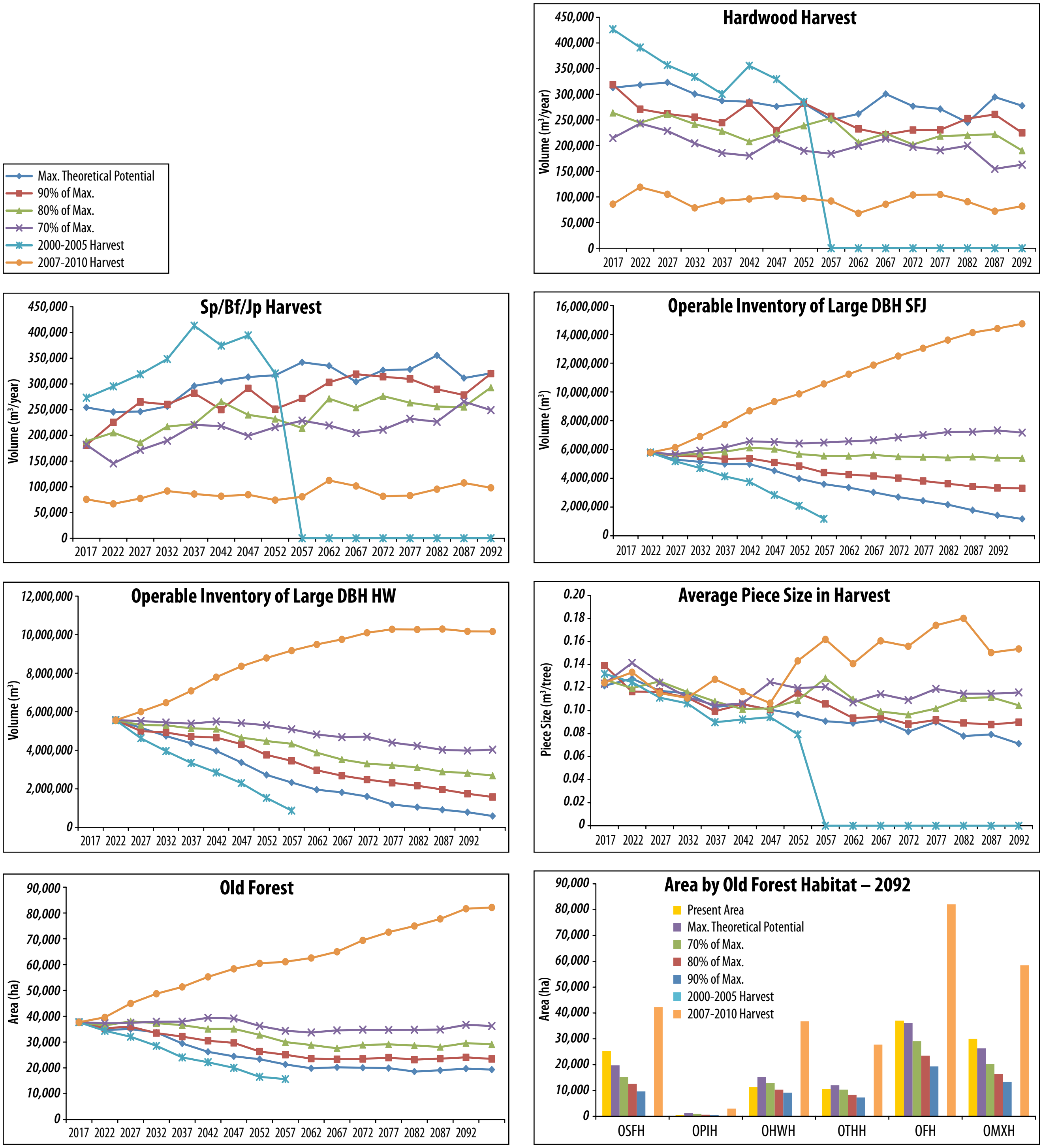


Figure 12: *Projected wood quality and forest structure indicators for the Northumberland Marketing Board following six alternative future harvest rates.*

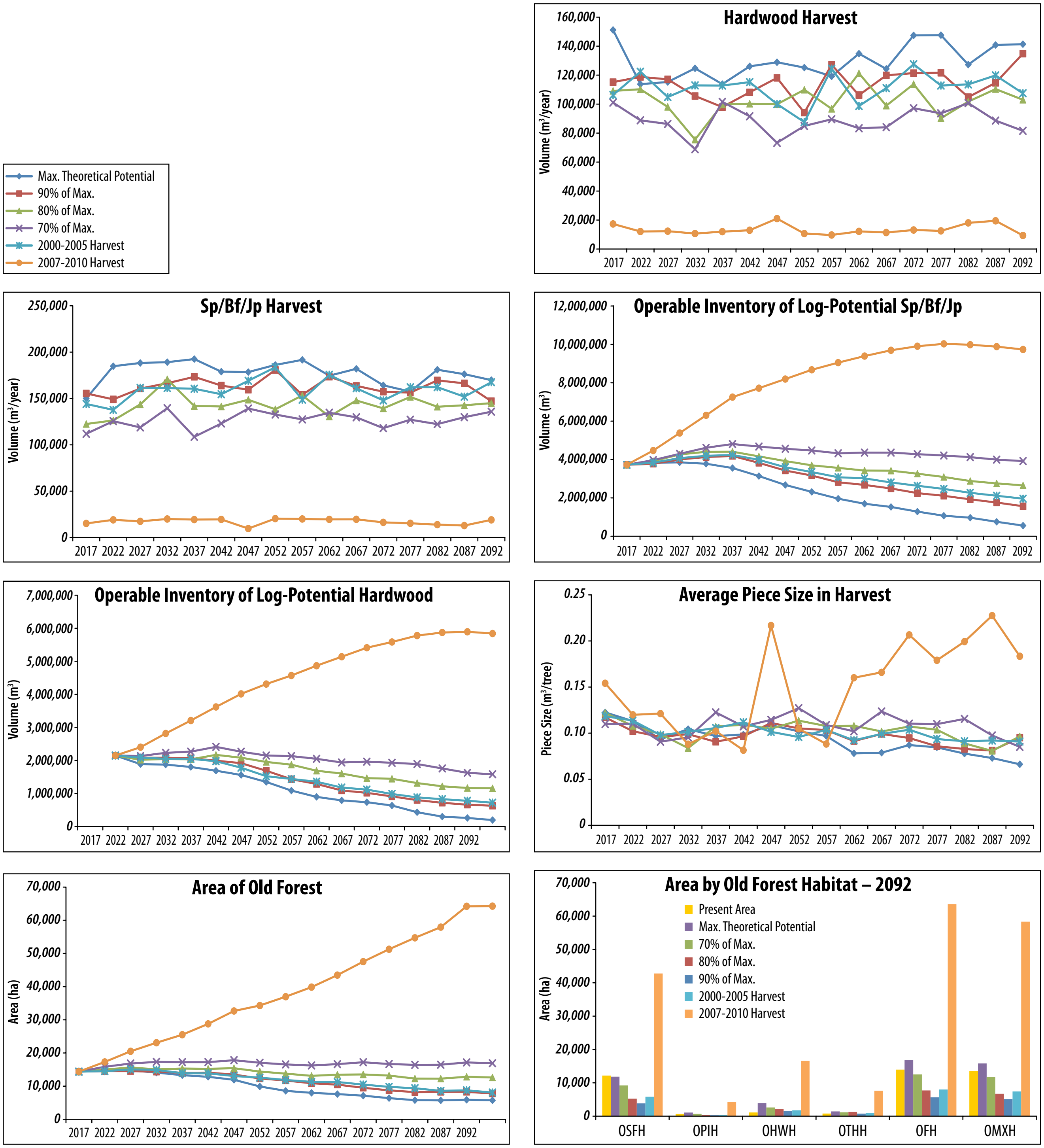


Figure 13: *Projected wood quality and forest structure indicators for the South-Eastern N.B. Marketing Board following six alternative future harvest rates.*

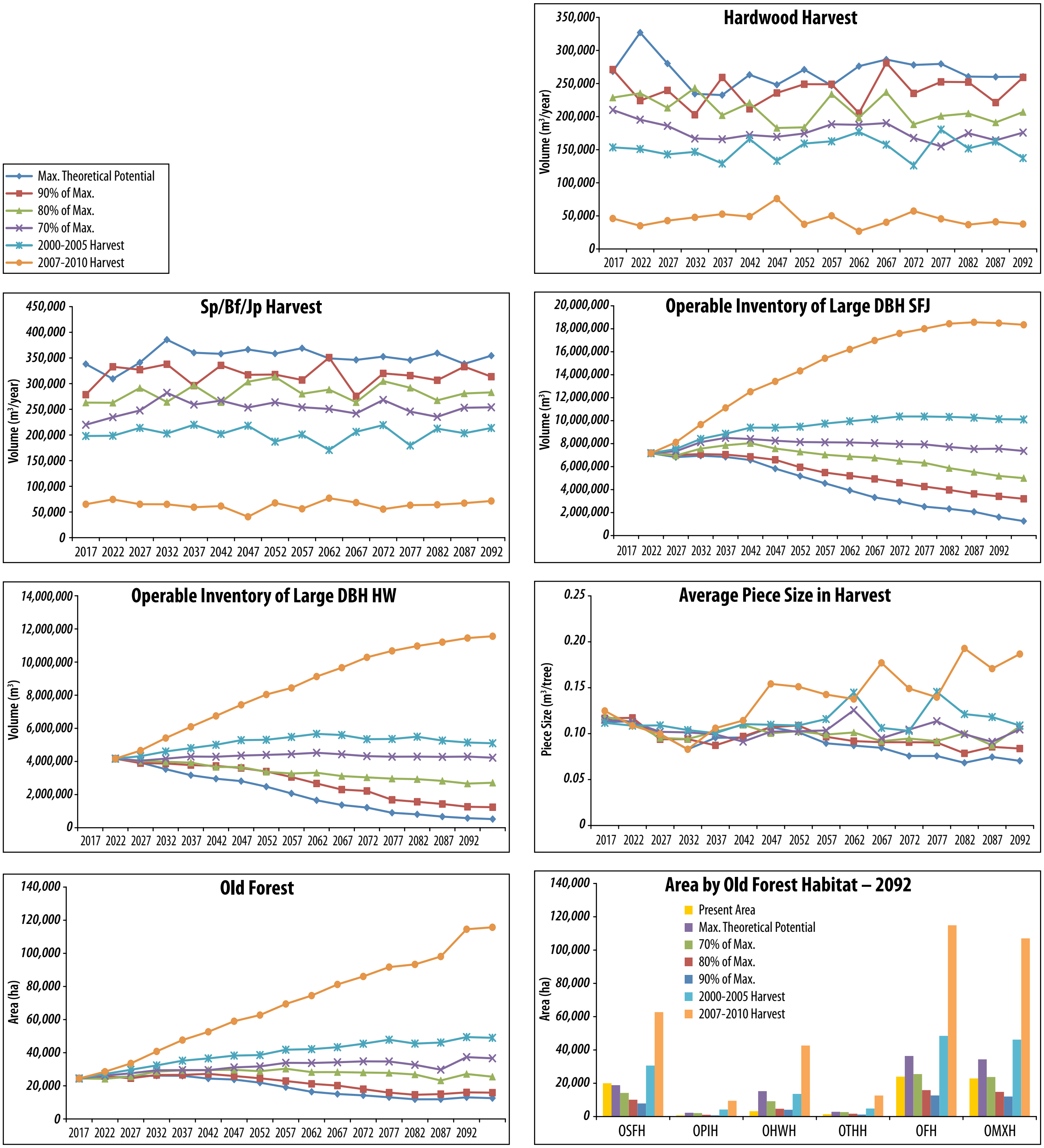


Figure 14: *Projected wood quality and forest structure indicators for the Southern N.B. Marketing Board following six alternative future harvest rates.*

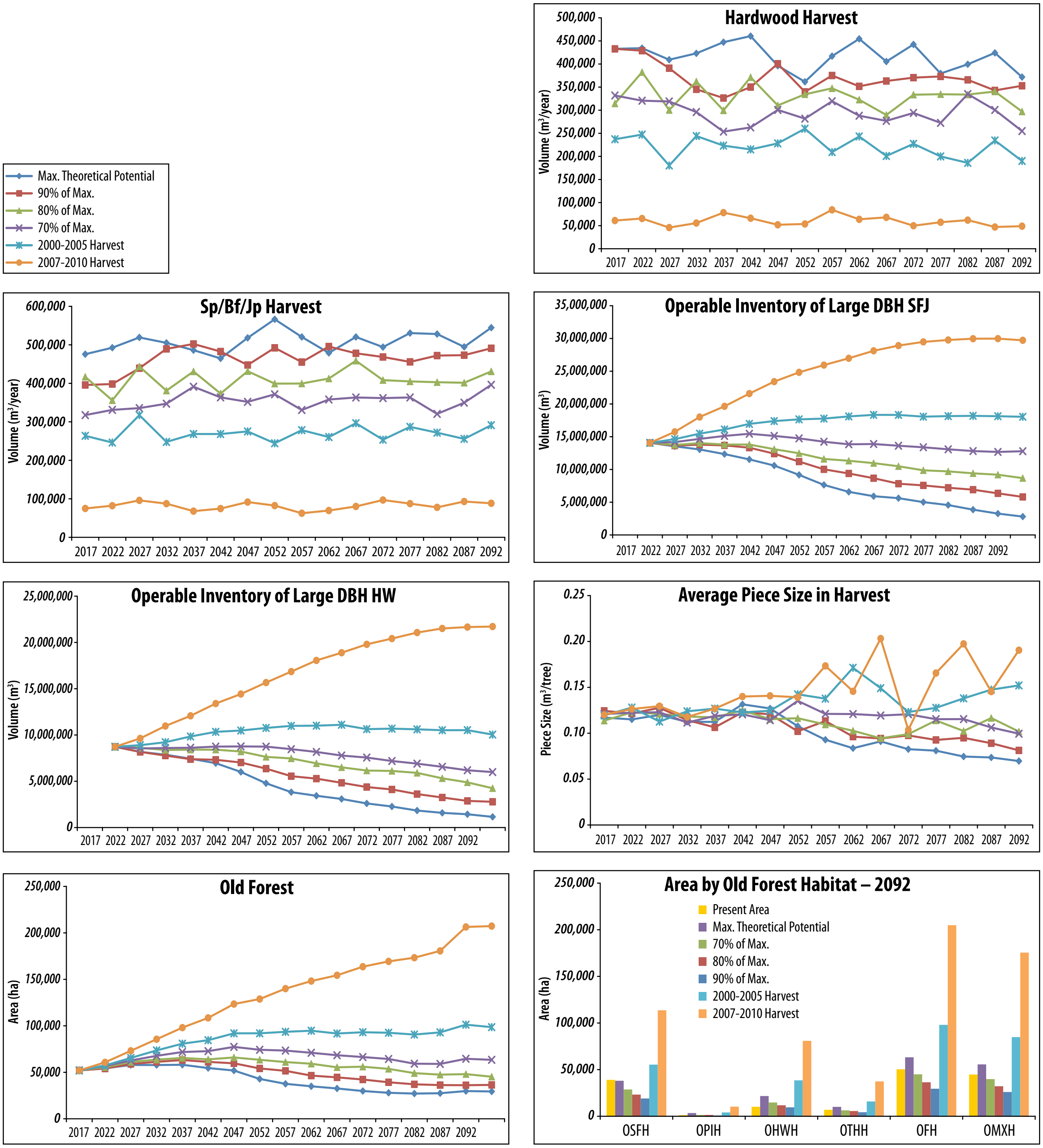
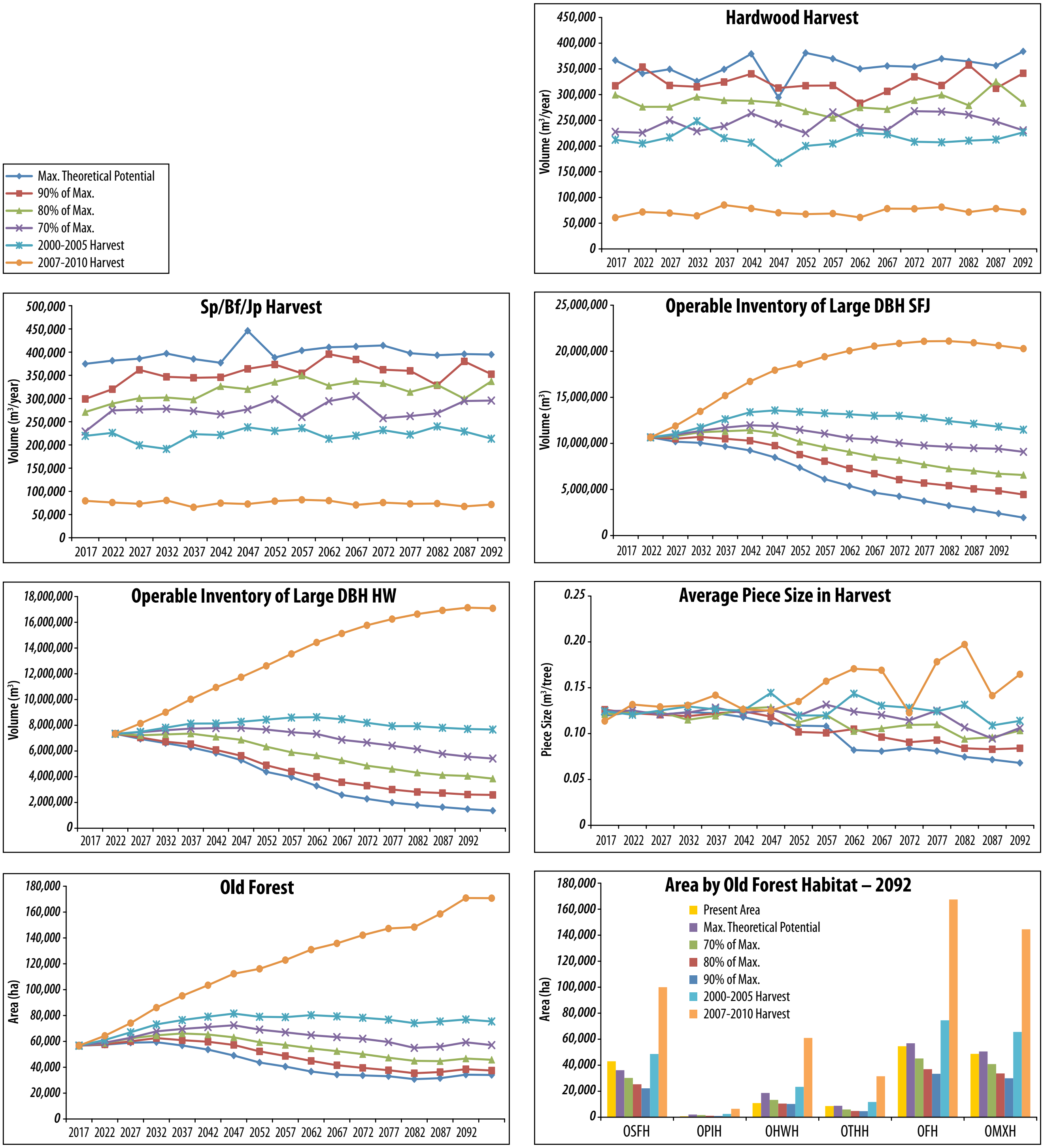


Figure 15: *Projected wood quality and forest structure indicators for the York-Sunbury-Charlotte Marketing Board following six alternative future harvest rates.*



Continuing the Recent Status Quo

In recent years, the annual harvest across Marketing Board areas has fluctuated considerably. Between 2000-2005, the forest industry was relatively stable and output of wood volume from private woodlots was at a recent high of 3.11 million m3/year. Following the 2006 downturn in the industry, wood volume being produced and sold by the Marketing Boards dropped dramatically. Between 2007-2010, annual production averaged 1.04 million m3/year, a drop of 67%.

What is clear from all indicators presented in this analysis is that the harvest in this most recent period is easily sustainable across all Marketing Boards. The depressed harvest rate during this time has led to recovery in operable growing stock of all species in all Boards. Potential exists to significantly expand the private woodlot supply today, although the extent to which AACs ought to recover to early 2000's levels is a matter of judgement.

Harvest pressure during the period of recent maximum activity varied considerably from region to region. While the provincial supply for both Sp/Bf/Jp and hardwood fell below what was determined to be the maximum theoretical supply, significant regional imbalances exist.

Most notably, the harvest in the North Shore area was clearly unsustainable. Harvest simulations forecasted a rapid decline in operable growing stock and harvested piece size before a forecasted collapse of supply mid-way through this century. No other Marketing Board area's harvest rate during this time of accelerated activity was so out of proportion to biological capacity.

The harvest in the two other northern Boards: Madawaska & Northumberland, could be described as aggressive during this period. While the total removal rate in these Boards was less than the maximum theoretical production capacity, classifying the harvest as sustainable comes with caveats. Most importantly, volume production in these areas as a result of mature forest composition would tend to supply a greater component of hardwood. Model forecasts suggest that Sp/Bf/Jp was specifically targeted from woodlots in these Board areas during the early 2000s. In both areas, sustaining the accelerated rate of Sp/Bf/Jp indefinitely would push the overall harvest to an unsustainable position given the suite of harvest options assumed at play and the current silviculture inputs. In addition, the harvested piece size declines steadily over the forecast and approaches a marginally operable 0.08 m3/tree by the end of the next century. Also of note is that the area of old forest and old forest wildlife habitats declines on both Boards in this scenario such that it is almost entirely concentrated in permanently unharvestable areas at the forecast's end. While recovery to early 2000s harvest rates is biologically possible in Madawaska & Northumberland, sustaining future harvest at these rates could come at a cost to wood quality, an increased proportion of hardwood, and with potential for loss in value to wildlife.

The results from simulating recent high harvest levels on the Carleton-Victoria Board were unique enough to warrant separate discussion. The overall harvest rate in this area was approximately 20% less than the potential production capacity, owing in part to the high fertility of woodlots in this area. The ratio of hardwoods to Sp/Bf/Jp harvest in Carleton-Victoria was more closely paired to forest composition over the period, but still suggested some targeting of softwoods. The log-potential harvest component of Sp/Bf/Jp is forecast to increase gradually over time. Still, the harvest rate during this period does cause instability in some key indicators. Harvested piece size declines over time from 0.14 m3/tree to eventually stabilize at 0.11 m3/tree. Operable growing stock of log-potential volume declines for both hardwood and Sp/Bf/Jp. Area of old forest declines over the first 50 years of simulation however eventually stabilizes. Area of old forest wildlife habitats are reduced at the end of the forecast, however some significant value is likely provided.

The remaining Boards in the south appear to have been harvested less aggressively in the period of peak activity. Projections for South-Eastern N.B., Southern N.B., and York-Sunbury-Charlotte, all point towards stability in harvest quality indicators and net forest growth. Simulations suggest that the abundance of old forest would expand and each Board would experience net gain in wildlife habitat. Significant potential exists to recover harvest levels on these Boards possibly beyond the levels experienced in the early 2000's.

Linking Harvest Pressure to Quality, & Forest Condition

The simulations presented quantify a clear and consistent pattern in all Boards showing a trade off between timber volume production, wood quality, and forest condition. It is clear that sustained harvesting at a Board's maximum biological capacity fails to meet some of the most basic tenants of modern sustainable forest management. What is less clear is the extent to which harvest ought to be scaled back from maximum capacity. This is particularly unclear where a clearly stated set of forest-level objectives are lacking for the woodlot owners under the various Marketing Boards. Unlike the Crown lands of N.B., there is no commonly held goal to provide an increasing supply of quality timber or to maintain native wildlife populations in the eco-districts where they would be naturally found. These objectives may appeal to individual woodlot owners, or they may not. In the absence of clear forest-level management objectives with measureable indicators, the notion of sustainability must be simplified. Can the forest continue to produce what it does today and will future generations inherit it in a more valuable condition that it is today?

Backing off harvest pressure by 10% of the theoretical maximum potential for each Board does impart a positive response in the indictors for wood quality and forest structure. Decline in average harvested piece size is tempered as is the decline in growing stock for log-potential material. At 90% of biological capacity, the harvest still leads to significant long-term reductions in old forest and wildlife habitats. Much of the older forest at this harvest level just meets the structural criteria at the projection's end and is concentrated highly in permanently unharvestable areas. Although volume production is sustainable in the long-term, it will come at this rate with the acknowledgement that some level of significant forest structure decline is acceptable.

What is more likely to meet a broad notion of sustainability is a harvest rate set at 20%-30% less than the biological capacity. Between these removal rates, most harvest quality and forest composition indicators stabilize over time. In most Boards, the log-potential growing stock of Sp/Bf/Jp experiences some recovery before stabilizing at or near today's levels. Log-potential hardwood stock experiences some gradual decline as a result of the current silviculture programs, particularly on the Boards where planting is favoured.

The area of old forest in the short-term is stable to increasing on all Boards at 70% of harvest capacity, after which most areas stabilize at or close to initial levels in the long-term. Wildlife habitat levels vary. 'Old Forest Habitat', 'Old Mixedwood Forest Habitat', and 'Old Hardwood Habitat' generally increase over the forecast and at 70-80% of harvest capacity, 5 of the 7 Boards finish scenarios with greater levels than they started with. Carleton-Victoria and the North-Shore however, still experience some moderate decline in some habitat types over the 80 year projection. 'Old Softwood Forest Habitat' experiences some decline in Carleton-Victoria, North-Shore, and YSC even harvesting at 70% of capacity. While levels are stable on the other Board areas, it's likely that the large patch-size requirements of this habitat type would mean the reported levels would be greatly reduced if spatially identified. With average woodlot sizes in N.B. far less than the patch size requirement of 375 ha, any suitable habitat areas would be likely spread over a number of individual owners and the potential for future habitat fragmentation high.

Table 9: *Annual Sp/Bf/Jp harvest volume (m3 - all products) expected as harvest pressure is reduced from the theoretical maximum. Expectations averaged over the first 25 years of the forecast. Recent historical harvest estimates of Sp/Bf/Jp by Board included for comparison.*

Board	Maximum Theoretical Rate	90% of Max.	80% of Max	70% of Max	2000-2005 Actual Harvest (% of Max)		2007-2010 Actual Harvest (% of Max)	
Carleton-Victoria	140,000	125,000	110,000	100,000	125,000	89.3%	135,000	96.4%
Madawaska	105,000	85,000	80,000	75,000	135,000	128.6%	80,000	76.2%
North-Shore	260,000	245,000	205,000	180,000	510,000	196.2%	95,000	36.5%
Northumberland	180,000	160,000	140,000	120,000	205,000	113.9%	20,000	11.1%
South-Eastern N.B.	345,000	315,000	275,000	250,000	285,000	82.6%	100,000	29.0%
Southern N.B.	495,000	445,000	405,000	345,000	345,000	69.7%	115,000	23.2%
York-Sunbury-Charlotte	385,000	335,000	290,000	265,000	295,000	76.6%	95,000	24.7%
Total	1,910,000	1,710,000	1,505,000	1,335,000	1,900,000	99.5%	640,000	33.5%

Table 10: *Annual hardwood harvest volume (m3 - all commercial species and products) expected as harvest pressure is reduced from the theoretical maximum. Expectations averaged over the first 25 years of the forecast. Recent historical harvest estimates of hardwood by Board included for comparison.*

Board	Maximum Theoretical Rate	90% of Max.	80% of Max	70% of Max	2000-2005 Actual Harvest (% of Max)		2007-2010 Actual Harvest (% of Max)	
Carleton-Victoria	190,000	175,000	150,000	125,000	160,000	84.2%	70,000	36.8%
Madawaska	145,000	140,000	115,000	95,000	105,000	72.4%	50,000	34.5%
North-Shore	310,000	270,000	250,000	215,000	245,000	79.0%	50,000	16.1%
Northumber-land	125,000	110,000	100,000	90,000	80,000	64.0%	10,000	8.0%
South-Eastern N.B.	270,000	240,000	225,000	185,000	95,000	35.2%	20,000	7.4%
Southern N.B.	430,000	385,000	330,000	305,000	175,000	40.7%	35,000	8.1%
York-Sunbury-Charlotte	345,000	325,000	285,000	235,000	135,000	39.1%	60,000	17.4%
Total	1,815,000	1,645,000	1,455,000	1,250,000	995,000	54.8%	295,000	16.3%

Sensitivity to Silviculture Input

All scenarios presented thus far have held constant the recent silviculture effort on each Board. However, at the request of the Task Force we present several alternative scenarios that explore the impacts of varying the silviculture budget. To that end we've tested the response in maximum theoretical harvest levels for both total and log-potential Sp/Bf/Jp under the presumption that its production is the primary purpose of current silviculture programs.

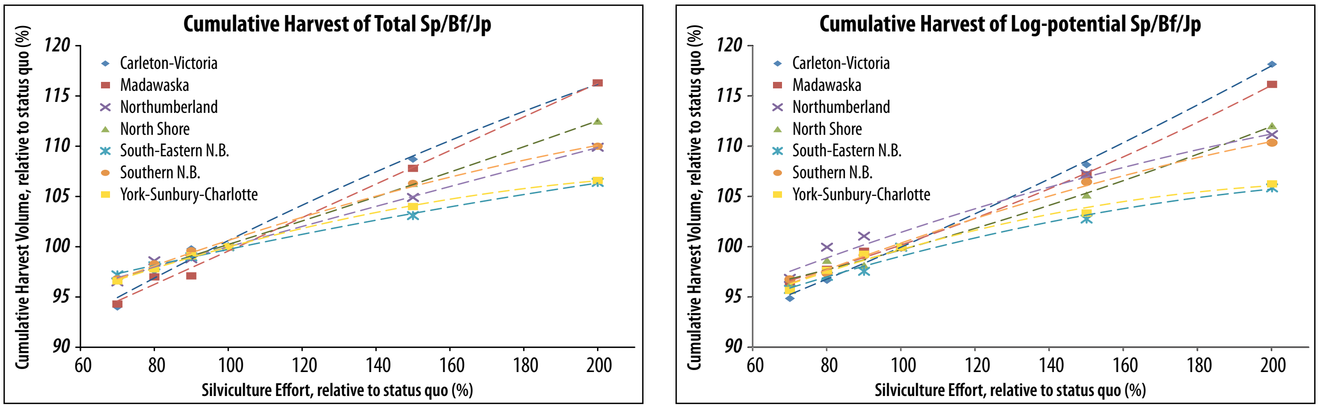
Both expansion and contraction of existing silviculture budgets were tested to varying degrees. Silviculture reductions were tested in 10% increments to a minimum of 70% of today's effort. Also simulated was a 50% expansion and a doubling of the existing programs. In each of these alternatives, the preferences between planting and pre-commercial thinning expressed in recent treatment history were held true for each Board. These existing ratios were assumed to be well calibrated to the local preferences and to the operational realities at play in each Board area.

Table 11: *The range of possible planting and pre-commercial thinning alternative program sizes tested in the wood supply forecasting. Specific scenarios designed at 70%, 80%, 90%, 100%, 150%, and 200% of today's effort level on each Board.*

	Planting			Pre-commercial Thinning		
Board	**30% Reduction**	**Status Quo**	**Doubling of Program**	**30% Reduction**	**Status Quo**	**Doubling of Program**
Carleton-Victoria	155	220	440	370	530	1,060
Madawaska	140	200	400	355	505	1,010
North-Shore	400	570	1,140	430	615	1,230
Northumberland	30	45	90	520	745	1,490
South-Eastern N.B.	25	35	70	820	1,170	2,340
Southern N.B.	310	445	890	855	1,220	2,440
York-Sunbury-Charlotte	15	20	40	995	1,420	2,840
Total	1,075	1,535	3,070	4,345	6,205	12,410

The results of the projections suggest that maximum theoretical harvest rates for Sp/Bf/Jp are relatively insensitive to the range of silviculture intensities tested, which may be counterintuitive. Both planting and pre-commercial thinning programs are justified with the expectation that they will bring improved stand structure in the way of desirable species at larger piece-size than natural post-clearcut regeneration at a given age. While this stand level relationship holds true for N.B.'s private woodlots, the broad forest-level context must be considered. Forest management strategies which include silviculture investments to sustain high supplies of Sp/Bf/Jp typically rely on precise harvest control to realize the investment at opportune future timing. In the case of private woodlot harvest, no such controls are in place in N.B. to ensure harvest takes place at a time that best contributes to landscape-level wood flow. As such, the effect of silviculture is to shift the composition of the forest to desirable structures, which will be harvested in approximate proportion to their abundance on the landscape at any given time. The following charts show how the volume of Sp/Bf/Jp realized over the 80 year projection varies with sustained change in today's silviculture effort.

Figure 16: *The change in cumulative harvest of Sp/Bf/Jp (log-potential & total volume) over the 80-year planning horizon with varying silviculture program size.*



The degree of the insensitivity is in line with an earlier finding. In Erdle's (2004) study, he tested similar scenarios of expanded silviculture programs on 5 of the Marketing Boards, and found an allowable cut effect of similar magnitude.

Not all Boards were found to be equally sensitive to silviculture inputs. The Carleton-Victoria, Madawaska, and North Shore areas were found to be most sensitive to both silviculture increases and reductions. These Boards tended to have the lowest inventory content of Sp/Bf/Jp in the mature forest today, higher preferences for planting, and in the cases of Carleton-Victoria & Madawaska, the highest potential productivity from plantations.

Finally, we must note that the wood supply model framework implicitly assumed that all plantings and thinnings would grow to a minimum age of 35 before they become part of the pool of harvest-operable stands. While delayed harvest beyond the age of peak mean annual increment can come at a loss of forest-level wood supply potential, early harvest of immature stands represents a significantly more dire loss. In this case the investment is lost at a fraction of its potential value. The model's framework was such that no treated stands were harvested at very early ages. Insofar that this may happen in reality, it would suggest that the wood supply sensitivity presented above is actually overstated.

Study Limitations & Recommendations for Future Analyses

Forest inventory is a particular challenge for wood supply analysis on N.B.'s private woodlots. Initializing forecasts with accurate inventory information is possibly the single most important determinant of the analyses' quality. In N.B. as a result of the forest inventory acquisition cycle, the photo interpreted attributes can be as much as 10 years out of date in a given geographic area. Although the natural growth & mortality processes in the Acadian forest operate relatively slowly, the rate of human induced harvest disturbance can vary greatly over a decade. On Crown lands, the photo forest inventory is augmented with annual digital mapping of all harvest activities. Such a periodic spatial update would greatly improve the initial inventory estimates on N.B.'s private woodlots. While the cost of remote sensing and ground based G.P.S. surveying is easily quantified, the cost of outdated inventories is more difficult to assess. This study was certainly influenced by the uncertainty surrounding recent harvest. However, given the timing of this analysis following several years of depressed industrial activity, it stands to reason that initial mature forest inventories used were likely more accurate than those used for the Erdle (2004) study.

In the absence of harvest mapping, an accurate scale is a valuable tool for initializing wood supply analysis. The full implementation of the Transportation Certificate system for tracking roundwood harvested from private woodlots has strengthened confidence in Board harvest estimates. This data, used in conjunction with the Timber Utilization Survey published annually by D.N.R. confidently estimates most volume harvested from woodlots for industrial use.

The forest inventory's most noticeable shortcoming on private woodlots is accurate spatial mapping of historical silviculture areas. The majority of planted and pre-commercially thinned areas on private woodlots were not detected in the photo-interpretation process, or were not described with the necessary attributes to facilitate wood supply planning. D.N.R. now receives from some Marketing Boards digital G.P.S. maps of areas receiving public reimbursement for silviculture. These files are of great benefit and if provided by all Boards, would work over time to greatly improve the inventory resolution for the managed stands.

Forest development survey data forms the basis for initializing yield estimates and forecasting strata forward in time. While the mature, unmanaged strata were well sampled with plots located on private woodlots, most managed strata and post-cutover regenerating forest had to be supplemented with Crown land plots. Where the harvest and silviculture systems used by large Crown licensees differ in character from those employed on private woodlots, it casts uncertainty on the validity of those forecasts. Greater sample intensity in these young conditions on private woodlots would alleviate this concern.

Natural regeneration patterns can be greatly influenced by the careful design of partial harvest prescriptions in suitable forest types. The suite of partial harvest regimes at play in N.B.'s private woodlots is likely underestimated by the photo interpreted inventory. Where woodlot owners may be conducting frequent removals of very low intensity, these harvests are difficult to detect given the resolution of D.N.R.'s inventory method. Consultation with Marketing Board staff and the N.B. Federation of Woodlot Owners led this analysis to rely on partial harvests to account for 10% of the periodic volume harvest. However, the sensitivity to this assumption was not explored in this set of analyses. Were practices to change in the woodlot sector away from reliance on clearcut harvest, a distinct wood supply picture would emerge. With any increased relevance, it would be prudent to place greater emphasis on the growth & yield data used to develop partial harvest response forecasts.

In the course of this analysis we have presented several patterns which seem to behave logically within the range of scenarios tested. It is important not to extrapolate those patterns to conditions which have not been explicitly tested. New land-bases, differing harvest rates, alternative treatments, or different silviculture funding scenarios may result in forest-level outcomes inconsistent with those presented here. The relatively costly phase of constructing wood supply models for each Board has been completed. Exploring additional simulations with those models is in contrast, inexpensive, and preferable to extrapolating the existing results.

It is important to carefully consider scale when applying notions of sustainability to private woodlots. The view taken in this analysis is that indicators such as old forest, growing stock, and harvested piece size hold value at the scale of the Marketing Board. Any individual private woodlot may, or may not, be managed sustainably at a given time so long as the larger collection of properties is operating within limits. The models used in this analysis certainly do not impose sustainable harvest considerations at the woodlot scale. We acknowledge that some readers may not share this view.

For any number of factors which have not been considered in this analysis, the wood supply levels reported may not be achievable in reality. In similar efforts conducted for Crown forests, a number of 'net-downs' are applied to strategic model results to arrive at an operationally feasible AAC. Unmapped watercourses subject to buffering requirements, landowners with permanent conservation goals, and permanent forest loss over time all stand to detract from the potential harvest rates predicted from the model. At the same time, certain factors which cause sizable net-downs on Crown forest are greatly reduced on the Marketing Boards. Private woodlots tend to be well accessed with roads. They tend to be on fertile land with little marginally productive forest. Also, difficult operating conditions related steep slopes, rockiness, and wet soils are thought to occur in far less frequency than Crown lands. Also at play in Crown land planning is a 'spatial cost' to wood supply as stands are harvested in large operational patches which depart from the optimized queue determined by the planning model. Whereas the private supply models did not utilize this optimal scheduling approach, it stands to reason that there is no cause for a 'spatial cost' to the estimated wood supply. Nevertheless, consideration for a 'net-down' to the figures presented here is warranted.

Forest management models such as the set used in this study are typically constructed to lead a landowner towards selecting a long-term strategy for the property. It leads them to conduct specific silviculture and harvest at carefully timed intervals in order to create a forest best suited to the management objectives. Where this analysis has covered 7 Marketing Boards and represented the properties of approximately 66,000 owners, each with their unique forest management objectives, it calls into question the value of a strategic plan with little hope for exact implementation. The very notion of an AAC for a collection of individual owners is largely academic since this province has no mechanism in place to force or deny harvest on any private holdings. That said, policy makers, industrial planners, Marketing Board representatives, and market consumers still hold a great interest in sustainable forest management and look to have insight the status of N.B.'s private holdings. It's our hope that the information presented is of value.

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