



Institut de recherche sur les feuillus nordiques Inc.  
Northern Hardwoods Research Institute Inc.



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# Technical Note

Silviculture

## Assigning hardwood potential to sites based on the NB forest site classification System

### INTRODUCTION

In tolerant hardwood and tolerant-mixedwood stand types, the determination of quality and productivity potential is an important yet difficult task for forest management and planning. Knowing the site's inherent potential is useful when deciding on investing limited time and resources. In the past, a variety of direct and indirect as well as phytocentric and geocentric measures of site productivity have been used (Bowling, C. and Zelazny, V. 1992). However, in hardwood and tolerant-mixedwood stands, the determination of site productivity is not a straight forward undertaking. We define "High Quality Hardwood Potential (HQHP)" as being the capacity of a forest site to produce quality hardwood trees and high yields. The project's main goal is to produce a GIS tool that will predict the hardwood potential for every 20 meters by 20 meters cells (NB reference Grid) based on variables such as climate, lithology, soil characteristics, and topographic metrics. The accuracy of the tool will be tested by validating the predictions using permanent sample plots (PSP) that contain information based on the NB Ecological Land Classification System (ELCS). This technical note explains how we have assigned a hardwood potential rating to each of those PSP's using the Treatment Unit concept which is part of the NB ELCS.

### HIGHLIGHTS

- The NB forest site classification system's primary interpretation is productivity although the original work focussed on softwood species.
- The white spruce's site index was used to establish the hardwood potential of Hardwood and TH-mixedwood Treatment Units because of its close ecological association with sugar maple and yellow birch.
- Missing white spruce's site index values have been estimated based on the region and the Treatment Unit's name.
- Hardwood and TH-mixedwood Treatment Units have been ranked based on those site index values.
- The other Treatment Units have been ranked using the SMYB-index developed by FORUS Research.
- One major weakness of the NB Site Classification System is that it relies on field assessments which makes it difficult to map variability at the stand scale.

# METHODOLOGY

The New Brunswick Ecological Land Classification System is founded on a four-level approach that includes: climate, geomorphology, regolith and site features. Each level is defined quantitatively through the use of environmental features known to affect tree growth and productivity (Bowling, C. & Zelazny, V. 1992).

Field guides to forest site classification (Appendix 1) has been produced covering all NB. Each guide contains an edatopic grid that covers the complete range in both nutrient and moisture regime (Bowling, C. & Zelazny, V. 1992).

An edatopic grid is an arrangement of stand types (ordination) in two dimensions (Figure 1) whose axes represent soil moisture regime (SMR) and soil nutrient regime (SNR) that are the two most important factors influencing site productivity (in combination with climate).

The species composition of any vegetation community reflects, among other things, soil conditions and processes related to plant nutrition and site productivity (Bowling, C. & Zelazny, V. 1992). For field identification purposes, SNR is determined using the Vegetation Type (VT) which is a recurring, mature vegetation community determined by the presence or abundance of certain indicator plants. On the other hand, Soil Types (ST) are identified through the use of variables such as drainage, depth to a compact layer, rooting space, mode of deposition, lithology, coarse fragment content, and horizon thickness (Appendix 2).

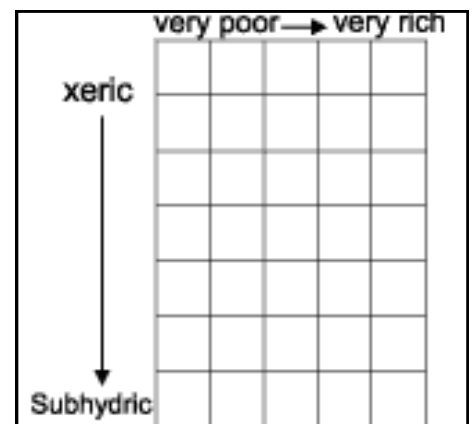


Figure 1. General edatopic grid.

Stand types are arranged on the grid so that similar stands (with respect to SMR and SNR) are close together, dissimilar ones far apart. The assumption here is that SMR and SNR are major factors driving stand species composition and development within a specific climatic region. Each climatic region has its own particular edatopic grid. Finally, stand types were grouped in Treatment Units (Appendix 3) which are site-specific landscape units with a relatively narrow range in both nutrient regime and drainage, and a certain level of productivity for commercial softwoods (Bowling, C. & Zelazny, V. 1992).

The NB forest site classification system primary interpretation is productivity (Bowling, C. & Zelazny, V. 1992). The system was developed to assign productivity levels to different softwood species like balsam fir, black spruce, white spruce and white pine. Site index is a measurement commonly used by foresters to describe the productivity of a site or stand of trees. This measurement usually describes well stocked even-aged forest stands. Site index (Appendix 4) is the average total height of both the dominant and co-dominant trees in a forest stand at a given age. That age is described as a base age which is usually age 50 in natural stands and age 25 in planted stands (<https://americanforestmanagement.com>).

## METHODOLOGY

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We have used the white spruce site index of all the Hardwood (HW) and Tolerant-mixedwood (THM) Treatment Units (TU) as an indicator of hardwood potential because this softwood species, among those sampled, has ecological needs relatively similar to hardwoods like sugar maple and yellow birch. Unfortunately, six TU were not assigned a site index, so we have estimated and assigned one ourselves. For HW and THM treatment units, the site index value was estimated by comparing it to the other TU site index name (which indicates soil's moisture and nutrient regimes) within the same ecoregion.

We then ranked those Hardwood and Tolerant-mixedwood TU in 3 categories of hardwood potential being Very High, High and Moderate. For defining the limits between each HW and THM TU category, we have passed the line where there was a relatively big step between 2 consecutive values.

All the other TU's (from Softwood, Intolerant-mixedwood and Intolerant-softwood stands) were assigned a Low potential and the ranking was done using the SMYB-index. This index was developed by FORUS Research (<http://www.forusresearch.com/speciesaffinity.php>) for the whole province. The SMYB-index is the probability of a site to grow sugar maple and/or yellow birch based on historical data and ecological, climatic, topographic and geologic variables. Using their position, we have extracted the PSP's SMYB value and calculated the average value for all the PSP of a same TU name/region. This average was then used to rank those TU from best (highest SMYB value) to worst (lowest SMYB value).

## RESULTS

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The final ranking of all the Treatment Units can be seen in Table 1.

Table1. Hardwood potential classification of all NB region's Treatment Units (1 of 2).

Region	TU#	TU_name	HW potential	Ranking	Classes
Restigouche	RE 11	Dry-Moist, Rich, Hardwood	1.00	1	VERY HIGH
Kedgwick	KE 6	Moist, Rich, TH-Mixedwood	0.95	2	
Restigouche	RE 10	Moist, Rich, TH-Mixedwood	0.90	3	
Restigouche	RE 7	Dry, Moderately Rich, TH-Mixedwood	0.90	4	
Upsalquitch	UP 11	Dry, Very Rich, TH-Mixedwood	0.80	5	HIGH
Napadogan-Tobique	NT 11	Dry, Rich, Hardwood	0.80	6	
Harvey-Harcourt	HH 13	Moist, Rich, Hardwood	0.75	7	
Fundy	FU 10	Dry-Moist, Rich, Hardwood	0.75	8	
Napadogan-Tobique	NT 8	Moist, Very Rich, TH-Mixedwood	0.75	9	
Sevogle	SE 10	Wet, Very Rich, TH-Mixedwood	0.75	10	
Harvey-Harcourt	HH 14	Dry, Rich, Hardwood	0.75	11	
Restigouche	RE 12	Very Dry, Moderately Rich, Hardwood	0.75	12	
Harvey-Harcourt	HH 15	Dry, Moderately Rich, Hardwood	0.75	13	
Napadogan-Tobique	NT 12	Very Dry, Rich, Hardwood	0.75	14	
Restigouche	RE 9	Dry, Rich, TH-Mixedwood	0.70	15	
Sevogle	SE 11	Dry, Rich, Hardwood	0.70	16	
Cains-Tracadie	CT 9	Moist, Very Rich, TH-Mixedwood	0.65	17	MOD
Upsalquitch	UP 12	Dry, Rich, TH-Mixedwood	0.65	18	
Cains-Tracadie	CT 10	Dry, Rich, TH-Mixedwood	0.60	19	
Big Bald	BB 11	Dry-Moist, Very Rich, TH-Mixedwood	0.50	20	
Big Bald	BB 12	Very Dry, Rich, TH-Mixedwood	0.45	21	
Napadogan-Tobique	NT 10	Very Dry, Moderately Rich, IH-Mixedwood	0.40	22	LOW
Fundy	FU 1	Very Dry, Poor, Softwood	0.40	23	
Fundy	FU 2	Dry, Poor, Softwood	0.35	24	
Napadogan-Tobique	NT 9	Dry, Moderately Rich, IH-Mixedwood	0.30	25	
Fundy	FU 9	Dry, Moderately Rich, IH-Softwood	0.30	26	
Fundy	FU 4	Very Wet, Very Poor, Softwood	0.30	27	
Fundy	FU 5	Wet, Moderately Poor, Softwood	0.30	28	
Napadogan-Tobique	NT 1	Very Dry, Very Poor-Poor, Softwood	0.30	29	
Restigouche	RE 2	Very Dry, Moderately Poor, Softwood	0.25	30	
Fundy	FU 7	Moist, Moderately Rich, IH-Softwood	0.25	31	
Restigouche	RE 6	Moist, Rich, Softwood	0.25	32	
Napadogan-Tobique	NT 7	Moist, Moderately Rich, Cedar-Softwood	0.25	33	
Fundy	FU 6	Wet, Rich, Softwood	0.20	34	
Restigouche	RE 8	Dry, Rich, Softwood	0.20	35	
Restigouche	RE 3	Dry-Moist, Moderately Poor, IH-Mixedwood	0.20	36	
Napadogan-Tobique	NT 2	Dry, Poor, Softwood	0.20	37	
Kedgwick	KE 8	Dry, Rich, IH-Mixedwood	0.20	38	
Fundy	FU 8	Wet, Moderately Poor, Softwood	0.15	39	
Upsalquitch	UP 10	Dry, Moderately Rich, Softwood	0.15	40	
Harvey-Harcourt	HH 11	Moist, Very Rich, IH-Mixedwood	0.15	41	
Kedgwick	KE 1	Dry, Poor, Softwood	0.15	42	
Napadogan-Tobique	NT 6	Moist-Wet, Moderately Poor, Softwood	0.15	43	
Fundy	FU 3	Moist, Moderately Poor, Softwood	0.15	44	
Upsalquitch	UP 9	Dry-Moist, Rich, Softwood	0.15	45	
Restigouche	RE 5	Wet, Rich, Cedar-Softwood	0.15	46	
Sevogle	SE 7	Moist, Moderately Rich, Softwood	0.15	47	
Big Bald	BB 8	Dry, Moderately Rich, IH-Mixedwood	0.15	48	
Sevogle	SE 6	Dry, Moderately Poor, Softwood	0.10	49	
Upsalquitch	UP 5	Dry-Moist, Moderately Rich, IH-Mixedwood	0.10	50	

Table1. Hardwood potential classification of all NB region's Treatment Units (2 of 2).

Region	TU#	TU_name	HW potential	Ranking	Classes
Napadogan-Tobique	NT 3	Dry-Moist, Moderately Poor, Softwood	0.10	51	LOW
Harvey-Harcourt	HH 12	Dry, Rich, IH-Mixedwood	0.10	52	
Upsalquitch	UP 4	Dry, Moderately Poor, IH-Mixedwood	0.10	53	
Sevogle	SE 1	Very Dry, Very Poor, Pine-Softwood	0.10	54	
Kedgwick	KE 4	Wet, Moderately Poor, Softwood	0.10	55	
Harvey-Harcourt	HH 10	Moist, Rich, IH-Mixedwood	0.10	56	
Restigouche	RE 1	Very Dry, Poor, Softwood	0.10	57	
Restigouche	RE 4	Wet, Moderately Poor, Softwood	0.10	58	
Sevogle	SE 8	Wet, Moderately Rich, Softwood	0.10	59	
Sevogle	SE 5	Wet, Poor, Softwood	0.10	60	
Upsalquitch	UP 8	Moist, Rich, Cedar-Softwood	0.10	61	
Kedgwick	KE 2	Dry, Moderately Poor, Softwood	0.05	62	
Big Bald	BB 9	Dry-Moist, Moderately Rich, IH-Mixedwood	0.05	63	
Upsalquitch	UP 3	Dry, Poor, IH-Mixedwood	0.05	64	
Cains-Tracadie	CT 7	Moist, Moderately Rich, IH-Mixedwood	0.05	65	
Kedgwick	KE 3	Moist, Moderately Poor, Softwood	0.05	66	
Cains-Tracadie	CT 8	Dry, Moderately Rich, IH-Mixedwood	0.05	67	
Harvey-Harcourt	HH 9	Moist, Rich, Cedar-Softwood	0.05	68	
Kedgwick	KE 7	Dry, Moderately Rich, IH-Mixedwood	0.05	69	
Sevogle	SE 3	Moist, Very Poor, Pine-Softwood	0.05	70	
Upsalquitch	UP 7	Wet, Moderately Rich, Cedar-Softwood	0.05	71	
Napadogan-Tobique	NT 4	Wet, Very Poor, Softwood	0.05	72	
Harvey-Harcourt	HH 8	Wet, Moderately Rich, IH-Mixedwood	0.05	73	
Harvey-Harcourt	HH 5	Very Dry, Moderately Poor, IH-Mixedwood	0.05	74	
Harvey-Harcourt	HH 6	Dry, Moderately Poor, IH-Mixedwood	0.05	75	
Harvey-Harcourt	HH 7	Moist, Moderately Poor, IH-Mixedwood	0.05	76	
Sevogle	SE 2	Dry, Poor, Softwood	0.05	77	
Sevogle	SE 4	Very Wet, Poor, Softwood	0.05	78	
Napadogan-Tobique	NT 5	Very Wet, Poor, Softwood	0.05	79	
Cains-Tracadie	CT 3	Wet, Poor, Softwood	0.05	80	
Upsalquitch	UP 2	Dry, Poor, Pine-Softwood	0.05	81	
Cains-Tracadie	CT 4	Wet, Moderately Rich, Cedar-Softwood	0.01	82	
Big Bald	BB 6	Dry, Moderately Poor, Softwood	0.01	83	
Big Bald	BB 4	Wet, Poor, Softwood	0.01	84	
Big Bald	BB 5	Very Dry, Moderately Poor, Softwood	0.01	85	
Cains-Tracadie	CT 5	Dry-Moist, Moderately Poor, Softwood	0.01	86	
Cains-Tracadie	CT 6	Very Dry, Moderately Poor, Pine-Softwood	0.01	87	
Sevogle	SE 9	Very Wet, Moderately Rich, Cedar-Softwood	0.01	88	
Harvey-Harcourt	HH 3	Wet, Poor, Softwood	0.01	89	
Upsalquitch	UP 6	Moist, Poor, Softwood	0.01	90	
Cains-Tracadie	CT 2	Moist, Poor, Softwood	0.01	91	
Big Bald	BB 3	Moist, Poor, Softwood	0.01	92	
Kedgwick	KE 5	Wet, Rich, Softwood	0.01	93	
Harvey-Harcourt	HH 2	Dry-Moist, Poor, Pine-Softwood	0.01	94	
Harvey-Harcourt	HH 4	Very Wet, Very Poor, Softwood	0.01	95	
Big Bald	BB 7	Moist, Moderately Poor, Softwood	0.01	96	
Cains-Tracadie	CT 1	Dry, Very Poor, Pine-Softwood	0.01	97	
Upsalquitch	UP 1	Dry, Very Poor, Pine-Softwood	0.01	98	
Harvey-Harcourt	HH 1	Very Dry, Very Poor, Pine-Softwood	0.01	99	
Big Bald	BB 1	Very Dry, Very Poor, Pine-Softwood	0.01	100	
Big Bald	BB 2	Dry, Poor, Softwood	0.01	101	
Big Bald	BB 10	Wet, Moderately Rich, IH-Mixedwood	0.01	102	

## DISCUSSION

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The ideal way of conducting this classification would have been to use hardwoods (sugar maple and yellow birch) growth and yield but this data was not available and would have required way too much time and resources to obtain. We think we have used the best information available today and are very pleased with the results. The next step is to continue the validation of the rankings and seek feedback and make any adjustments if necessary. Finally, the ranking and/or categories' limits will be verified and revised (if necessary), in the future as the decision tree / GIS tool site potential predictions will undergo field validations.

## CONCLUSION

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This exercise was necessary in order to have a validation method of the hardwood potential predictions eventually obtained using the decision tree and/or geomatic tools. Without this validation method, the decision tree and GIS tool would be useless.

Based on our field experience, the final ranking looks fairly robust. The best potentials are found in the Restigouche, Kedgwick, Upsalquitch and Napadogan-Tobique regions. On the other hand, Big Bald and Cains-Tracadie have the lowest potential of the Hardwood and TH-mixedwood Treatment Units. We also think that it is logical to have all the Treatment Units associated with Softwood and Intolerant-softwood/mixedwood in the Low category. Appendix 5 illustrate a preliminary draft version of HW site potential map .

## REFERENCES

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- Bowling, C. and Zelazny, V. 1992. Forest site classification in New Brunswick. *For. Chron.* 68: 34–41.
- Klinka, K. and Carter, R.E. 1990. Relationships between site index and synoptic environmental factors in immature coastal Douglasfir stands. *For. Sci.* 36: 815-830.
- Zelazny, V., T. Ng, M. Hayter, C. Bowling and D. Bewick. 1989. Field guide to forest site classification in New Brunswick: Kedgwick and Restigouche Site Regions. New Brunswick Department of Natural Resources and Energy, Fredericton, N.B.

## ACKNOWLEDGEMENT

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## Appendix 1

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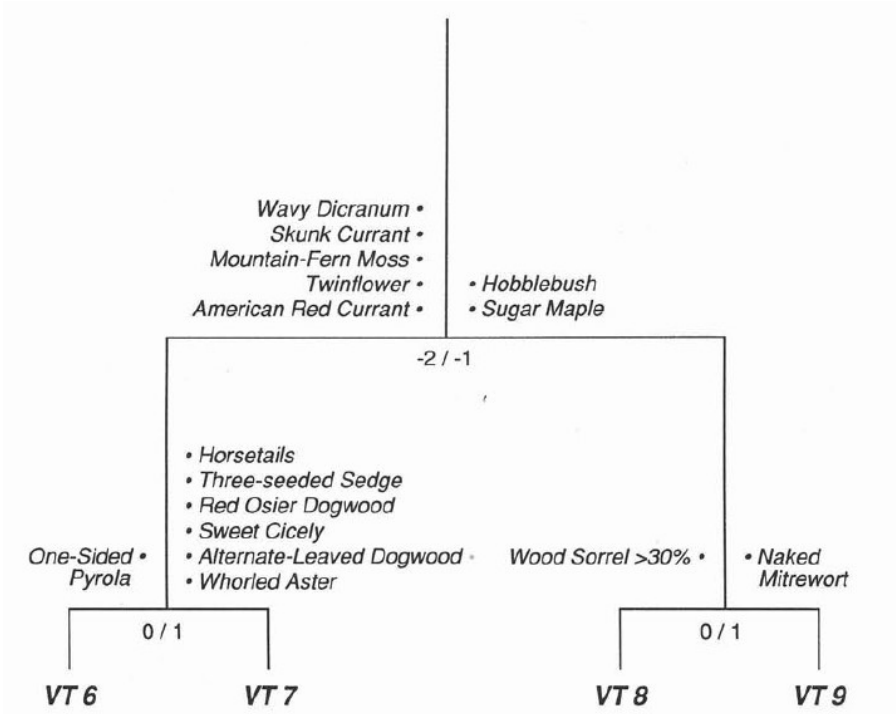
Field guide to forest site classification in NB for the Kedgwick—Restigouche ecoregions.



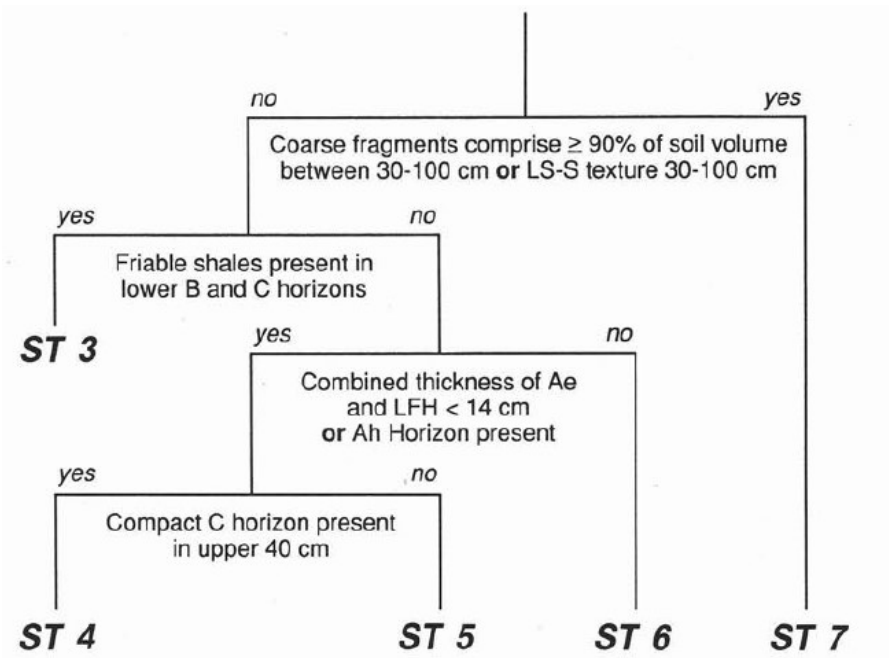


# Appendix 2

Portions of the identification keys for finding the Vegetation Type (VT) and the Soil Type (ST) for the Restigouche ecoregion.



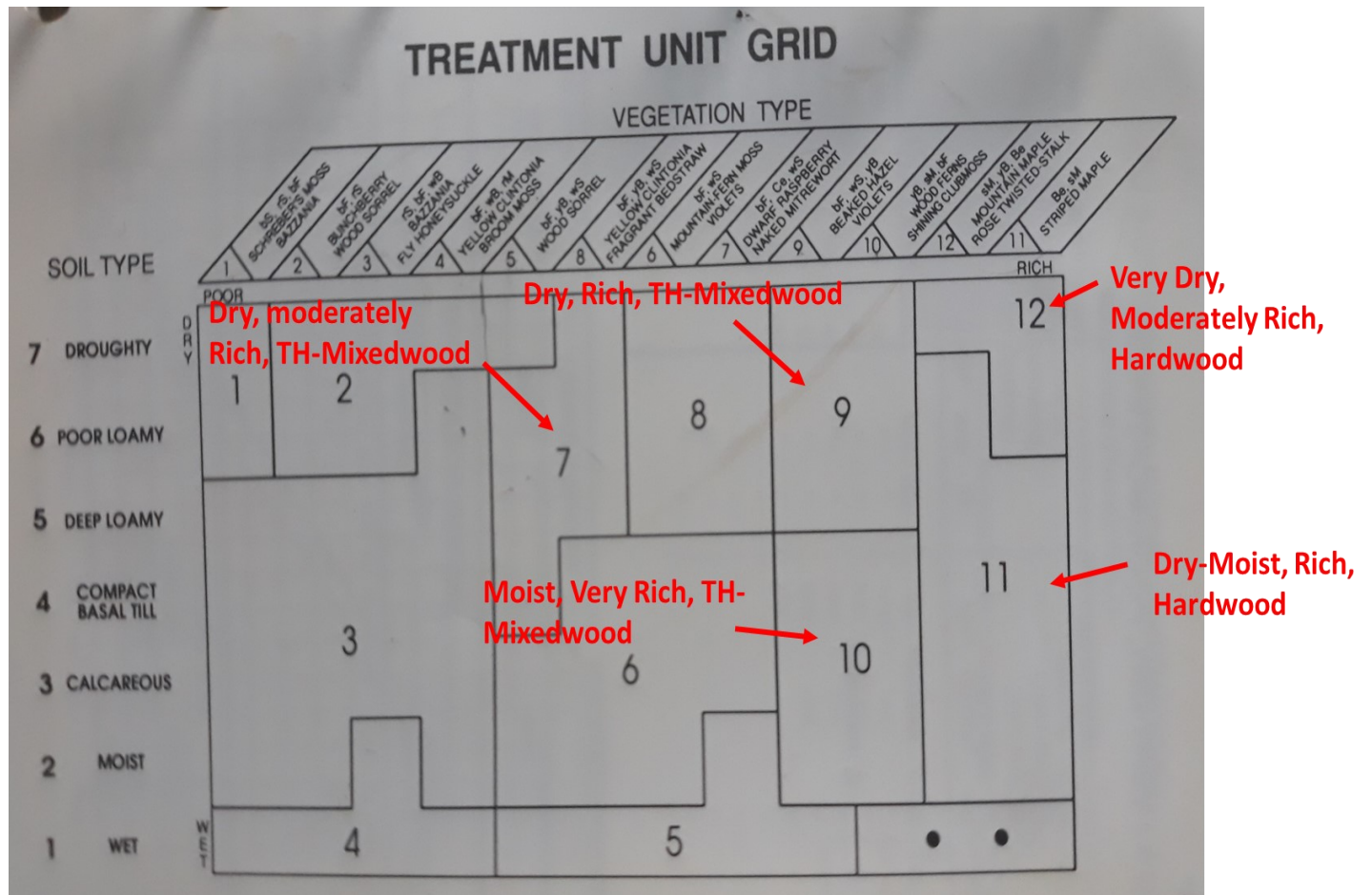
1– Portion of the Vegetation Type field key of the Restigouche ecoregion



2– Portion of the Soil Type field key of the Restigouche ecoregion

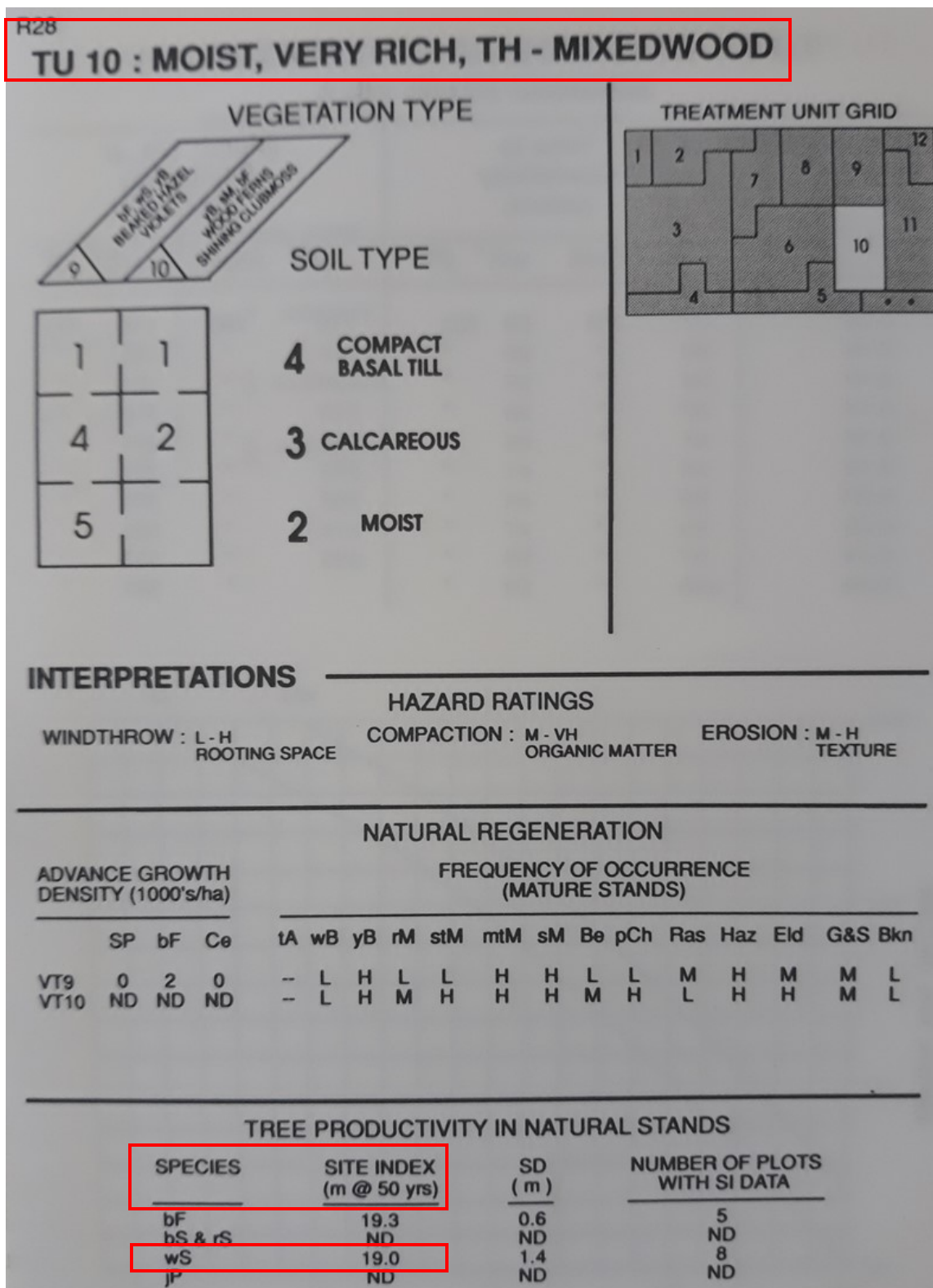
# Appendix 3

Treatment Unit grid from the Restigouche ecoregion.



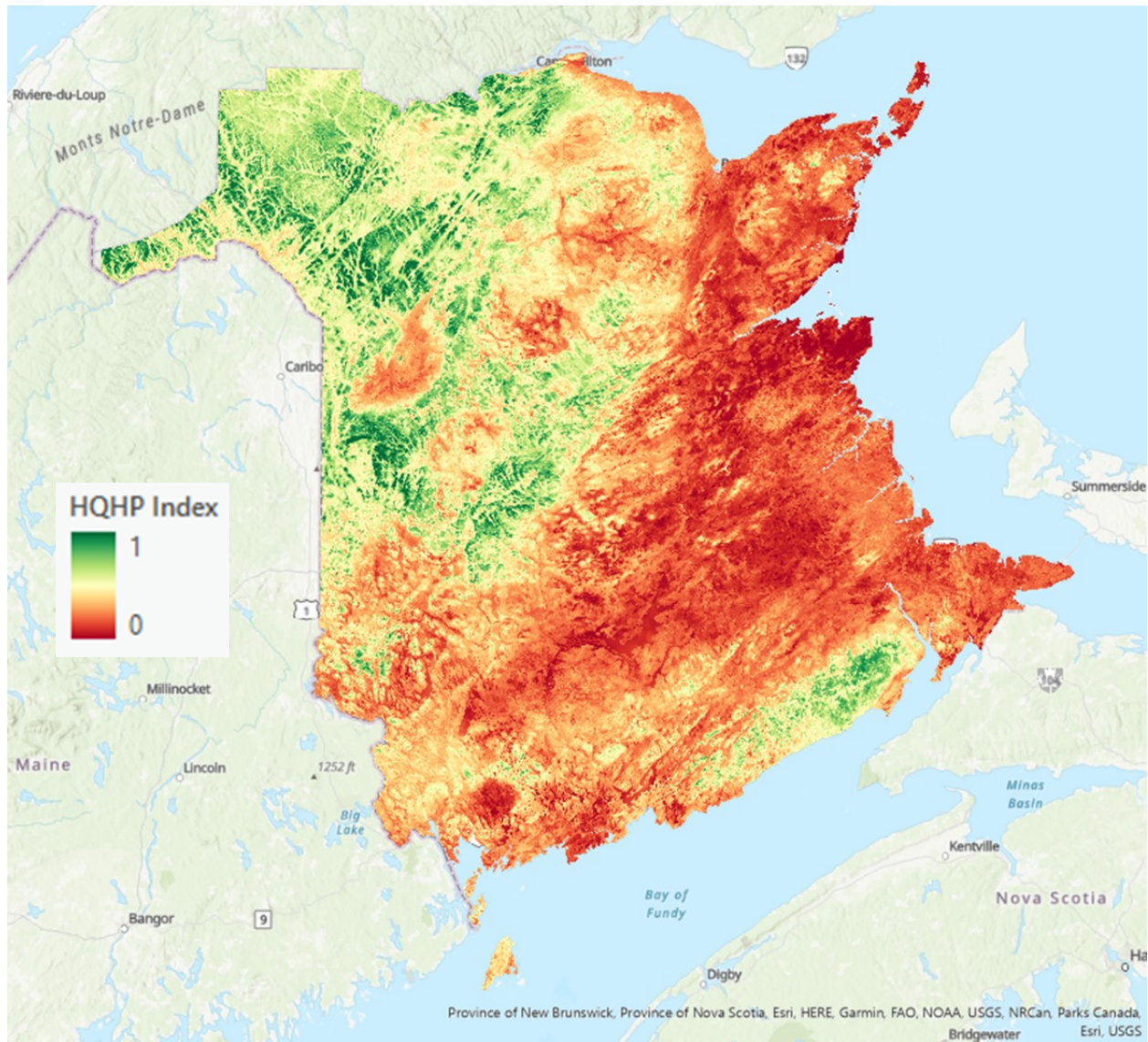
## Appendix 4

Treatment Unit 10 of the Upsalquitch ecoregion with information on different species site index.



## Appendix 5

Preliminary draft version of HW site potential map for the province of New Brunswick.







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