

2012

Equivalent Cut Area (ECA) study of the Restigouche River Watershed



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INTRODUCTION

It is now recognized that forest harvesting may change the hydrological regime of rivers and notably increase the peak flows (Plamondon, 1993). The increase in peak flow of a river can alter the morphology of the stream (Faustini, 2000) and, consequently, the aquatic habitat (Roberge, 1996).

This study is aimed to assess the condition of the Restigouche River watershed in relation to the types of forestry work carried out and their distribution. The method of calculating the equivalent cut areas (ECA), based on a regressive rate of the cut effect (RRCE) was made to map the watershed. The calculation was done for the year 2010, with ArcGIS 9.3.1 for harvesting of the previous 35 years.

The calculation of ECA was conducted on New Brunswick Crown Lands located within the Restigouche River watershed (Figure 1). It therefore goes in the licenses 1 and 9, respectively managed by AvCell and Acadian Timber. In addition to the main stretch of the Restigouche River, major tributaries in the study are the Little Main Restigouche, Kedgwick, Upsalquitch and Patapédia rivers.



Figure 1. Study area

The calculations were performed on the watersheds of levels 1 to 5. Literature and

calculations allow us to identify watersheds that can demonstrate a risk of hydrological regime modification by logging, which are those approaching or exceeding 50% of ECA.

METHODOLOGY

Delineation of watersheds

Because watershed levels 3, 4 and 5 were not available in geomatics layer, a delineation of these was carried out with the extension "Hydrologic modeling" of ArcGIS, the contribution of UNB (Castonguay, 2011). Since this tool usually gives acceptable results, but imperfect, validation and adjustments were made manually.

Regressive Rate of the Cut Effect (RRCE)

Forest disturbances have some influence on a watershed by multiplying the increase in peak flows of the rivers, posing a risk of it affecting aquatic habitat. This effect of forest disturbance on peak flows varies from cover reduction. Thus, the effects of partial cutting will be less than a clearcut. The effects will fade with time, as reconstitution of the canopy and the restoration of compacted soils return to its natural state (Plamondon, 2004).

The RRCE are weighing factors of the effect of the cut that integrate various features of deforestation. RRCE standards were developed during studies in Quebec. These studies were estimated for all types of cuts, silviculture treatment and natural disturbances. They were presented in the document « Méthode de calcul de l'aire équivalente de coupe d'un bassin versant en relation avec le débit de pointe des cours d'eau dans la forêt à dominance résineuse. » de Langevin et Plamondon en 2004.

The RRCE's found in this study have been adjusted to the terminology of types of cuts and silviculture activities found in the New Brunswick forestry (Appendix 1). A RRCE as been applied to each forest disturbance of the

last 35 years to assess its impact "equivalent" in an immediate clearcutting (Appendix 2).

Equivalent cut area (ECA)

The ECA represents the cumulative area of a watershed that has been harvested or cleared naturally, expressed in terms of a freshly cut surface during the past year by clearcut.

The equivalent cut area (ECA) of a watershed represents the sum of areas of each of the disturbances, which are multiplied by their respective value in RRCE. The percentage of equivalent cut area of a watershed is obtained by dividing the sum of ECA by its total basin area.

The ECA is expressed as a percentage and according to studies on this methodology, the critical threshold of ECA is 50%, beyond which the risk of negative impact of forestry on the hydrological regime are emphasized.

As mentioned in the previous section, the effects of disturbance on flow regime are based upon various factors, including the type of intervention and age. Taking into account all these factors when calculating the harvested area of a watershed leads therefore to express it in terms of equivalent cut area (ECA). The ECA represents the cumulative area of the watershed that has been harvested or cleared naturally in various ways over time, brought back to a freshly clearcut surface.

RESULTS

The Figure 2 shows the distribution of disturbances and their respective RRCE color codified value for the entire study area.

The Figure 3 presents the calculation of ECA for Crown Lands. This allows to locate watersheds demonstrating a risk of altered hydrological regime.

Finally, Figure 4 shows two examples of watershed where we can observe the value of

RRCE for each disturbances and their impact at the ECA.

In light of the results, areas upstream of the Northwest Upsalquitch River watershed, and some tributaries of the Patapedia River watershed could be at risk.

ACKNOWLEDGMENTS

We wish to thank the personnel of the following organization for their help in this study: UNB, AV Cell, Acadian Timber, New Brunswick Dep. Natural Resources and especially the principal funding contributor, the Royale Bank of Canada.



DATA SOURCES

Watersheds/relief/hillshades: In collaboration with M. Mark Castonguay of the Forest Watershed Research Center at UNB.

Hydrological elements: DNRNB
Forest stands: DNRNB
Recent forest interventions: AVCell/Acadian Timber

Coordinates System:
NAD-1983_CSRS_NB_stereographic

Map created by: Ken Bouchard (CTFM)

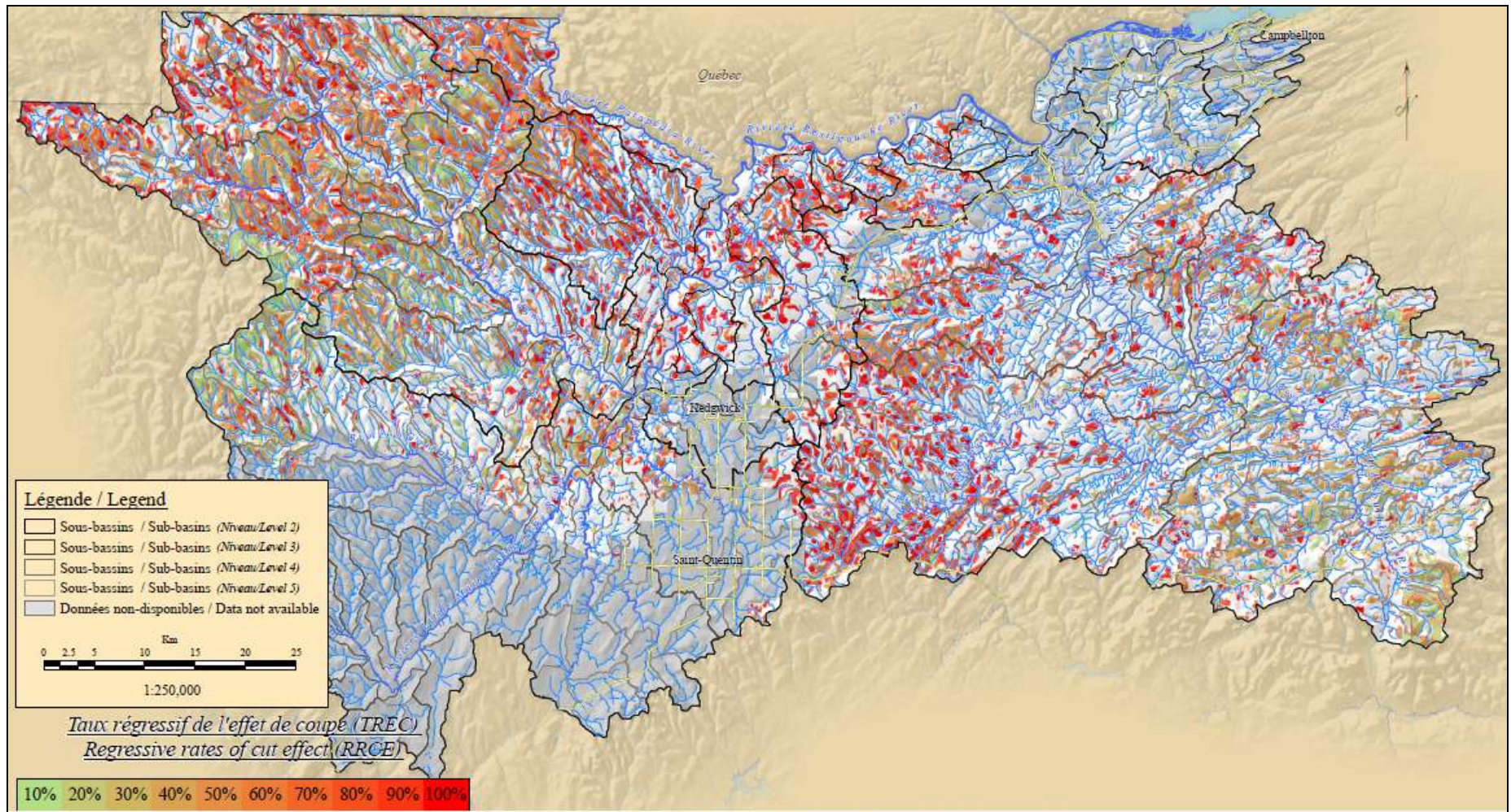


Figure 2. Attribution of RRCE per perturbations.

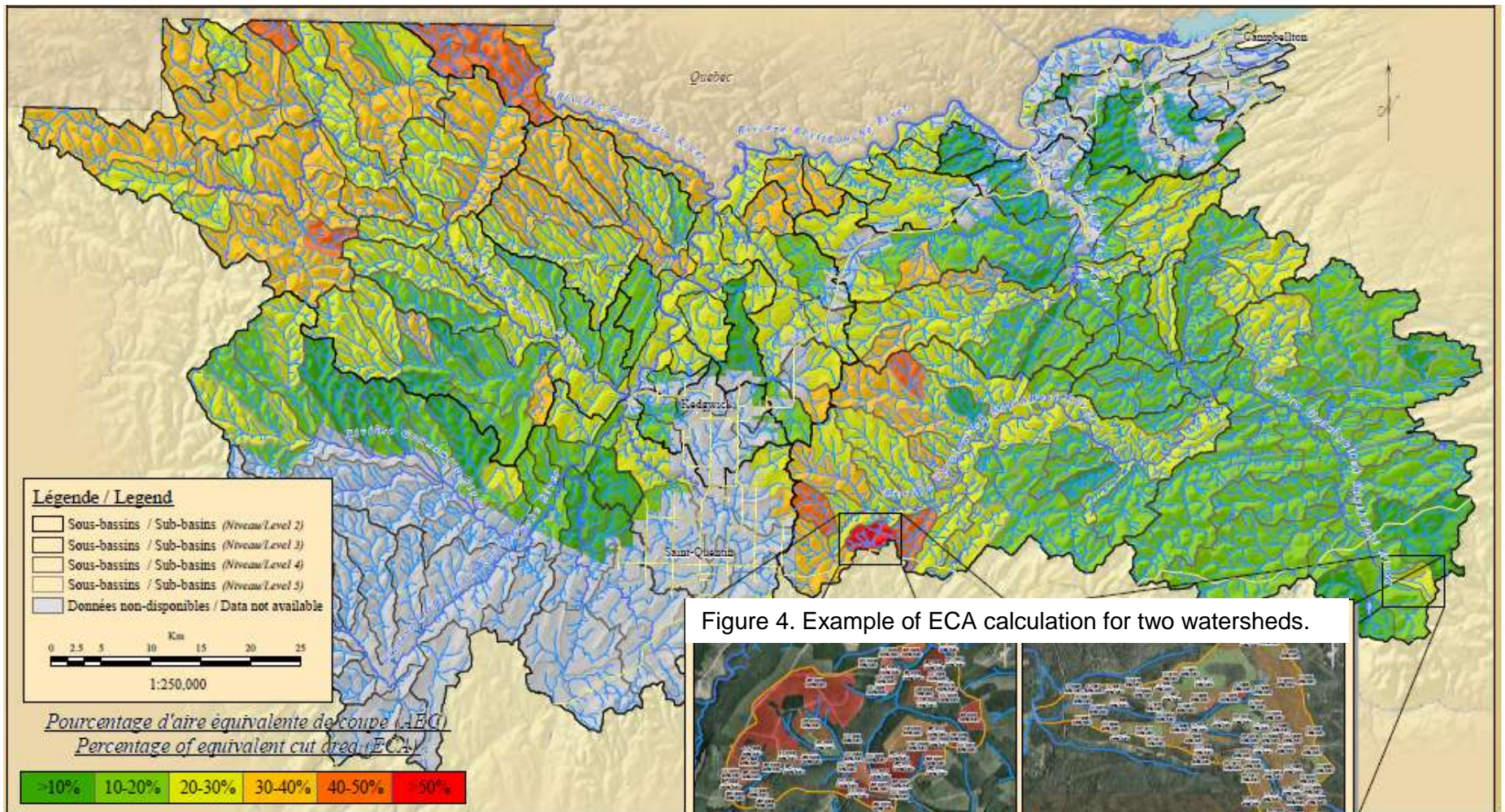
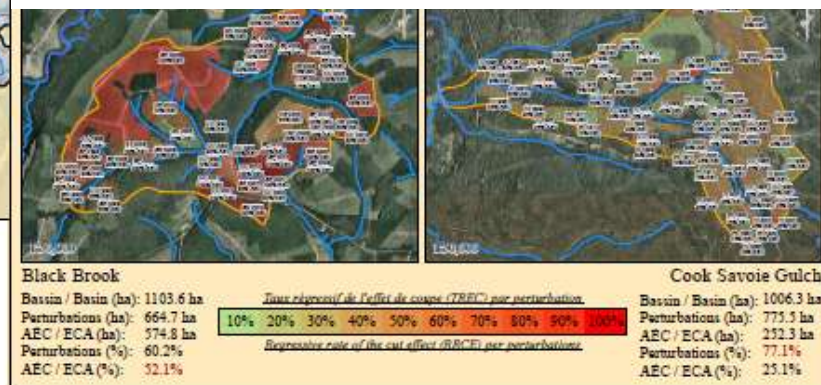


Figure 3. Percentage of ECA per watersheds (2010)

Figure 4. Example of ECA calculation for two watersheds.



Appendix 1. Twinning of Quebec's code with codes used in New Brunswick with descriptions.

<u>Code (NB)</u>	<u>Name of the disturbance (NB)</u>	<u>Used by:</u>	<u>Code (QC)</u>	<u>Name of the disturbance (QC)</u>
B	Burn (DNR)	<i>MRN NB</i>	BR	Brûlis total
BB	Burn (DNR)	<i>MRN NB</i>	BR	Brûlis total
BB	Herbicide (AT)	<i>Acadian Timber</i>	BR	Brûlis total
BF	Fill Planting (AT)	<i>Acadian Timber</i>	RRR	Regarnis de plants cultivés en récipient
BP	Full Plantation (AT)	<i>Acadian Timber</i>	P	Plantation
BS	Scarification (AT)	<i>Acadian Timber</i>	P	Plantation
BT	Pre-Commercial Thinning (AT)	<i>Acadian Timber</i>	EPC	Éclaircie Précommerciale
BU	Old Burn (AT)	<i>Acadian Timber</i>	BR	Brûlis total
C	Cut (DNR)	<i>MRN NB</i>	CT	Coupe totale Coupe protection haute régénération et sols
CCR	Clearcut Advanced Regeneration (AT)	<i>Acadian Timber</i>	CPH	Éclaircie Précommerciale
CL	Plantation Cleaning (DNR)	<i>MRN NB</i>	EPC	Éclaircie commerciale
CT	Commercial Thinning (DNR)	<i>MRN NB</i>	EC	Éclaircie commerciale
CTR	Crop Tree Release (AT)	<i>Acadian Timber</i>	CJ	Coupe de jardinage
DSH	Dense Shelterwood (AT)	<i>Acadian Timber</i>	CPM	Coupe progressive mélangé
DF	Fill Planting (AT)	<i>Acadian Timber</i>	RRR	Regarnis de plants cultivés en récipient
DP	Planting (AT)	<i>Acadian Timber</i>	P	Plantation
DT	Pre-Commercial Thinning (AT)	<i>Acadian Timber</i>	EPC	Éclaircie Précommerciale
FC	Plantation Cleaning (AT)	<i>Acadian Timber</i>	EPC	Éclaircie Précommerciale
FP	Fill Planting (DNR)	<i>MRN NB</i>	RRR	Regarnis de plants cultivés en récipient
FW	Fuelwood Clear Cut (DNR)	<i>MRN NB</i>	CT	Coupe totale
HM	Tolerant Hardwood Selection (AT)	<i>Acadian Timber</i>	CP	Coupe partiel
GS	Tolerant Hardwood Group Selection (AT)	<i>Acadian Timber</i>	CJ	Coupe de jardinage Dégagement chimique de la régénération
HB	Herbicide (AT)	<i>Acadian Timber</i>	DRC	Éclaircie Précommerciale
IT	Intermediate Thinning (DNR)	<i>MRN NB</i>	EPC	Éclaircie Précommerciale
LR	Hardwood Sawlog Removal (AT)	<i>Acadian Timber</i>	CP	Coupe partiel Coupe protection haute régénération et sols
OR	Overstory Removal (DNR)	<i>MRN NB</i>	CPH	Coupe protection haute régénération et sols
ORTH	Overstory Removal Tolerant Hardwood(DNR)	<i>MRN NB</i>	CPH	Coupe protection haute régénération et sols
OSH	Open Shelterwood (AT)	<i>Acadian Timber</i>	CPM	Coupe progressive mélangé
PA	Patch Cut (DNR)	<i>MRN NB</i>	CB	Coupes par bandes
PB	Old Burn (AT)	<i>Acadian Timber</i>	BR	Brûlis total
PC	Partial Cut (DNR)	<i>MRN NB</i>	CP	Coupe partiel
PL	Planting (DNR)	<i>MRN NB</i>	P	Plantation Coupe protection haute régénération et sols
RC	Regeneration Protection Clear Cut (DNR)	<i>MRN NB</i>	CPH	Éclaircie Précommerciale
RC	Remedial Cleaning (AT)	<i>Acadian Timber</i>	EPC	Éclaircie Précommerciale
RF	Fill Planting (AT)	<i>Acadian Timber</i>	RRR	Regarnis de plants cultivés en récipient
RI	Fill Planting (AT)	<i>Acadian Timber</i>	RRR	Regarnis de plants cultivés en récipient
RP	Full Plantation (AT)	<i>Acadian Timber</i>	P	Plantation

<u>Code (NB)</u>	<u>Name of the disturbance (NB)</u>	<u>Used by:</u>	<u>Code (QC)</u>	<u>Name of the disturbance (QC)</u>
RR	Residual Removal (AT)	<i>Acadian Timber</i>	CRR	Récolte tiges résiduelles et rebuts
RU	Full Plantation (AT)	<i>Acadian Timber</i>	P	Plantation
SA	Salvage Cut (DNR)	<i>MRN NB</i>	CA	Coupe assainissement
SC	Selection Cut (DNR)	<i>MRN NB</i>	CJ	Coupe de jardinage
SCTH	Selection Cut Tolerant Hardwood (DNR)	<i>MRN NB</i>	CJ	Coupe de jardinage
SE	Seed Tree Cut (AT)	<i>Acadian Timber</i>	CRS	Coupe avec réserve de semenciers
SH	Shelterwood cut (DNR)	<i>MRN NB</i>	CPM	Coupe progressive mélangé
SHEL	Shelterwood Cut (DNR)	<i>MRN NB</i>	CPM	Coupe progressive mélangé
SHELTH	Shelterwood Tolerant Hardwood (DNR)	<i>MRN NB</i>	CPF	Coupe progressive feuillus
SR	Softwood Removal Cut (DNR)	<i>MRN NB</i>	CP	Coupe partiel
ST	Strip Cut (DNR)	<i>MRN NB</i>	CB	Coupes par bandes
SWR	Softwood Removal in TH Stands (AT)	<i>Acadian Timber</i>	CP	Coupe partiel
TI	Pre-Commercial Thinning (DNR)	<i>MRN NB</i>	EPC	Éclaircie Précommerciale
TP	Two Pass Shelterwood (AT)	<i>Acadian Timber</i>	CPM	Coupe progressive mélangé
W	Windthrow (DNR)	<i>MRN NB</i>	CHT	Chablis total
XT	Excelerated Thinning (AT)	<i>Acadian Timber</i>	EPC	Éclaircie Précommerciale

*These two codes (BB et RC) was not meaning the same thing at Acadian Timber and at DNR. Codes were changed * manually beforehand (for B and CL respectively) in the Acadian Timber shapefile.*

Appendix 2. Regressive rate of Cut effect by age of the disturbance. (Adapted from Langevin et Plamondon, 2004)

TREC Standard par type d'intervention ou de perturbation (%)										
Âge de la perturbation	Coupes Totales		Coupes Progressives		Sylvicultures				Naturel	
	Traditionnel	Protection de régénération	Coupes par section	Coupes par prescription	Éclaircies commerciales	Plantations	Éclaircies pré-commerciales	Herbicides	Chablis	Feux
(Année)	<i>C, CC</i> <i>FW, RR</i> <i>SE</i>	<i>CCR</i> <i>OR</i> <i>ORTH</i> <i>RC</i>	<i>PA</i> <i>ST</i>	<i>DSH, HM, GS, LR</i> <i>OSH, PC, SA, SC</i> <i>SCTH, SH, SHELTH</i> <i>SR, SWR, TP</i>	<i>CT</i> <i>CTR</i>	<i>BF, BP, BS,</i> <i>DF, DP, FP</i> <i>PL, RF, RI</i> <i>RP, RU</i>	<i>BT, CL</i> <i>DT, FC</i> <i>IT, TI</i> <i>XT</i>	<i>HB</i>	<i>W</i>	<i>B</i> <i>BB</i> <i>BU</i> <i>PB</i>
0	100	85	50	35	35	100	85	100	80	100
1	100	80	50	30	30	100	80	95	80	100
2	100	75	50	25	25	100	75	90	80	100
3	100	70	50	20	20	100	70	85	80	100
4	100	65	50	15	15	100	65	80	80	100
5	100	60	50	10	10	100	60	75	80	100
6	95	55	47,5	5	5	95	55	70	75	95
7	90	55	45	0	0	90	55	65	70	90
8	85	50	42,5	0	0	85	50	60	70	85
9	80	45	40	0	0	80	45	55	65	80
10	75	45	37,5	0	0	75	45	55	60	75
11	70	40	35	0	0	70	40	50	55	70
12	65	35	32,5	0	0	65	35	45	50	65
13	60	35	30	0	0	60	35	45	50	60
14	55	30	27,5	0	0	55	30	40	45	55
15	55	30	27,5	0	0	55	30	35	40	55
16	50	25	25	0	0	50	25	35	40	50
17	45	25	22,5	0	0	45	25	30	35	45
18	45	20	22,5	0	0	45	20	30	35	45
19	40	15	20	0	0	40	15	25	30	40

TREC Standard par type d'intervention ou de perturbation (%)

Âge de la perturbation	Coupes Totales		Coupes Progressives		Sylvicultures				Naturel	
	Traditionnel	Protection de régénération	Coupes par section	Coupes par prescription	Éclaircies commerciales	Plantations	Éclaircies pré-commerciales	Herbicides	Chablis	Feux
(Année)	<i>C, CC</i> <i>FW, RR</i> <i>SE</i>	<i>CCR</i> <i>OR</i> <i>ORTH</i> <i>RC</i>	<i>PA</i> <i>ST</i>	<i>DSH, HM, GS,</i> <i>LR</i> <i>OSH, PC, SA, SC</i> <i>SCTH, SH,</i> <i>SHELTH</i> <i>SR, SWR, TP</i>	<i>CT</i> <i>CTR</i>	<i>BF, BP, BS,</i> <i>DF, DP, FP</i> <i>PL, RF, RI</i> <i>RP, RU</i>	<i>BT, CL</i> <i>DT, FC</i> <i>IT, TI</i> <i>XT</i>	<i>HB</i>	<i>W</i>	<i>B</i> <i>BB</i> <i>BU</i> <i>PB</i>
20	35	15	17,5	0	0	35	15	25	30	35
21	35	15	17,5	0	0	35	10	20	30	35
22	30	10	15	0	0	30	10	15	25	30
23	30	10	15	0	0	30	5	15	25	30
24	25	10	12,5	0	0	25	0	15	20	25
25	25	10	12,5	0	0	25	0	10	20	25
26	20	5	10	0	0	20	0	10	15	20
27	15	0	7,5	0	0	15	0	10	15	15
28	15	0	7,5	0	0	15	0	10	10	15
29	15	0	7,5	0	0	15	0	5	10	15
30	10	0	5	0	0	10	0	0	10	10
31	10	0	5	0	0	10	0	0	10	10
32	10	0	5	0	0	10	0	0	10	10
33	10	0	5	0	0	10	0	0	5	10
34	5	0	2,5	0	0	5	0	0	5	5
35	0	0	0	0	0	0	0	0	0	0