Biodiversity-based Compartment Prioritization.

In support of Millar Western's 2007 – 2016 Detailed Forest Management Plan.

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Introduction

Millar Western Forest Products ltd. (MWFP) are in the process, with the quota holders within their FMA to develop a harvest schedule that will be mostly spatially driven by compartments. Compartments are spatial sub-units of the FMUs that encompass between 1000 and 7000 ha (W13= 3 402 +/- 1 958 ha, W11= 2 168 ha +/- 1 345 ha (Mean +/- StDev). As MWFP wants to control their harvesting at that spatial level by constraining by periods harvesting in selected compartments, it is important to formerly identify special forest conditions that needs to be maintained for biodiversity purposes until other areas can provide comparable ecological benefits.

Goal

To provide MWFP with guidelines in compartment sequencing for harvesting with regards to rare biodiversity values and to reduce the risks of irreversibility in certain forest conditions.

Methodology

Both Forest Management Units (W13 and W11) have been looked after at the landscape level for rarity and ecological representativeness analyses. As harvesting is more likely to affect mature and old forest habitats, we undertook analyses focusing on these features and their related spatial conditions. Four analyses have been conducted:

1. Stand age class distribution
2. Large tracts of forest being of the same seral stage (inverse of fragmentation)
3. Rarity of forest stand types
4. Diversity of forest stand types

With the stand age class distribution, we wanted to identify which compartment had the most of old-growth forest. To do so, we determined an area-weighted average and standard deviation age by compartment. We wanted to identify not only the oldest compartments but also the ones that had the least variation in age. This provided a good indication of how the forest age is distributed inside each compartment.

In the second analysis, we wanted to identify large tracts of forest having the same age. Particularly, we were interested in detecting old-growth large tracts. To do so, we ran a sliding window average age and standard deviation spatial analysis with Arc-Gis. The window sizes used were 100 ha, 500 ha, 1000 ha and 5000 ha.

With the third analysis, we looked at the diversity of stand types. Stand types were defined as the combination of vegetation types (Deciduous, Deciduous-dominating mixedwood, Coniferous-dominating mixedwood, Coniferous), density classes (A, B, C, D) and age classes (0-50 years, 51-100 years, 101-150 years, 151-200 years, 201+ years). In this analysis, we looked at the distribution of all the stand types in the compartments. Stand types that were occurring in less than ten compartments were considered as rare. We listed the compartments where these stand types were rare.

For the last type of analysis, we looked at the diversity of stand types in each compartment. Diversity was assessed using the number of different stand types and the value of the Shannon-Weiver diversity index.

Results

Age analysis

Stands greater than 80 years were considered importance based upon the age class distribution of the actual landscape (Figure 1).

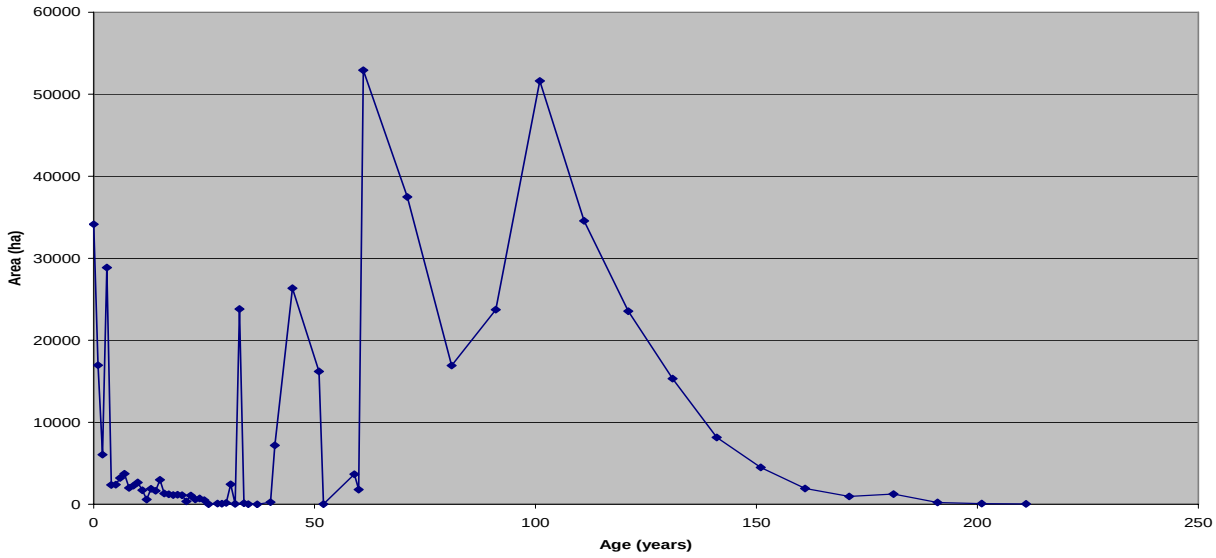

Figure 1. MWFP's FMA age class distribution.

Based on that criteria, we identified 1 compartment in W13-W9N, five compartments in W13-W9S, six compartments in W11 and none in W5 that had an average age greater than 78 years (Figure 2, Table 1).

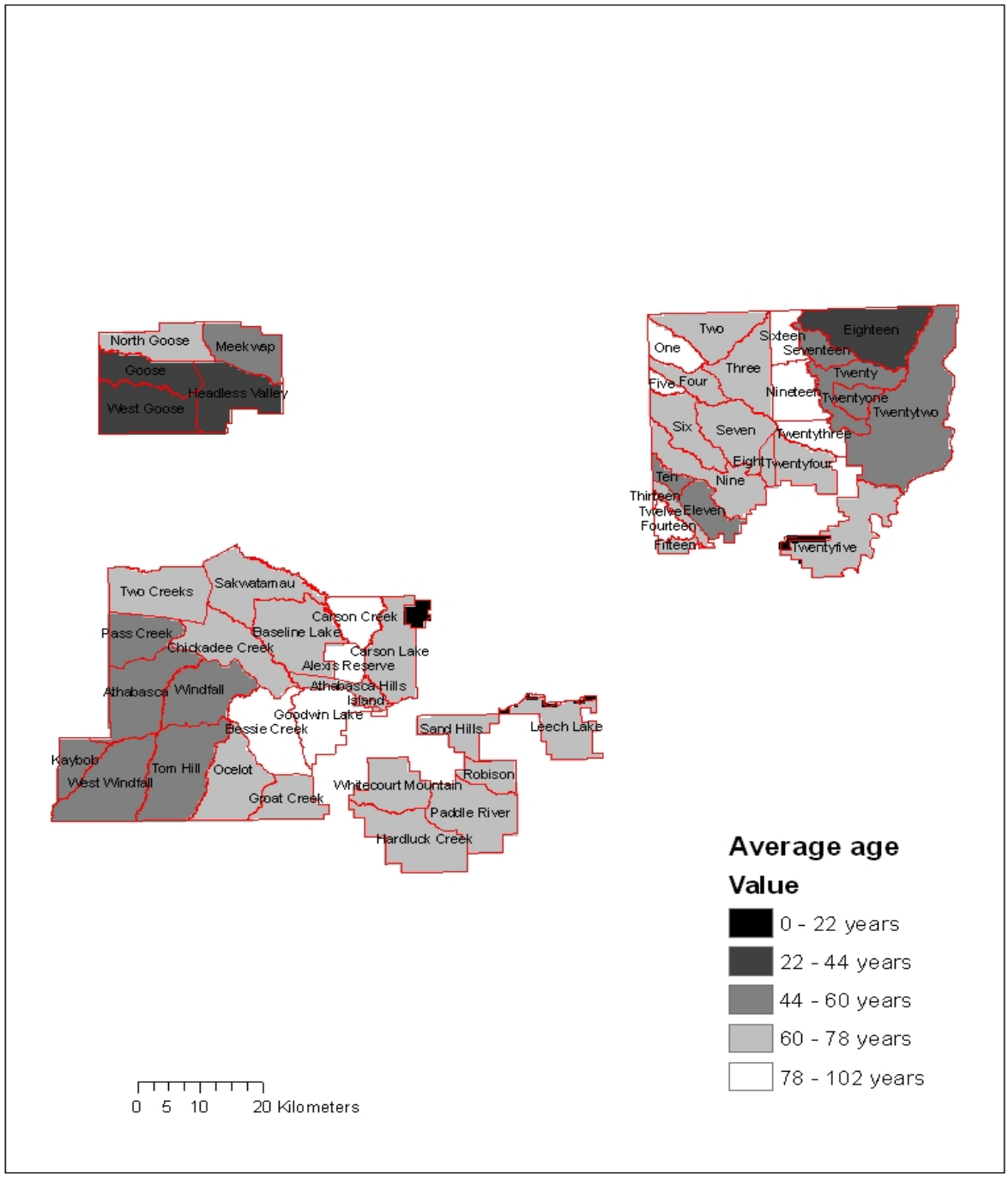

Figure 2. Area-weighted average age of the compartments in MWFP's FMA.

Table 1. Compartment identified by Forest Management Unit to bear biodiversity values according to the different analysis conducted for MWFP's entire FMA.

Indicators		W13 -(W9N)	W13 -(W9S)	W13 -(W5)	W11
Age		North Goose	Carson Creek, Baseline Lake, Bessie Lake, Alexis Reserve, Goodwin Lake		One, Five, Fourteen, Sixteen, Nineteen, Twentythree
Age variation		West Goose	Pass creek, West Windfall, Whitecourt Mountain		Fourteen, Fithteen, Nineteen
Old growth large tracts		North Goose	Goodwin Lake, Carson Creek, Baseline Lake, Alexis Reserve, West Windfall	Hardluck Creek	Five, Fourteen, Sixteen, Nineteen, Twenty-Three, Twenty-four, Twenty-five
Homogeneous age tracts		West Goose, Headless Valley	Pass creek, Chickadee creek, West Windfall, Whitecourt Mountain		Two, Fourteen, Fifteen, Sixteen, Nineteen, Eighteen, Nineteen, Twenty-Five
Rarity					
Stand type	D_B_2		Baseline Lake		
	D_C_3		Baseline Lake		
	C_B_3		Baseline Lake		
	D_D_4		Baseline Lake, Chickadee Creek		
	DC_D_4		Athabaska Hills		Twenty-two
	CD_A_2		Baseline Lake, Carson Creek		
	C_D_1	Headless valley, Meekwap	Goodwin Lake		
	D_A_3	Headless valley, Meekwap	Chickadee Creek		
	C_A_5	Meekwap	Tom Hill, Windfall	Hardluck Creek	
	D_C_1		Baseline Lake, Carson Creek, Ocelot, Tom Hill		
	C_B_5		Baseline Lake, Athabasca, Athabasca Hills		Eleven, Twentyfive
	DC_B_4		Athabasca Hills, Baseline Lake, Carson Lake	Hardluck Creek, Paddle River, Whitecourt Mountain	ElevenTwentyfive
	DC_D_3	Goose, Headless Valley, Meekwap, North Goose	Alexis Reserve, Baseline Lake, Sakwatamau, Two Creeks		
	DC_C_2	Headless Valley, Meekwap, West Goose	Athabasca, Kaybob, Sand Hills, Tom Hill, West Windfall, Windfall		
Diversity	Richness	Headless Valley	Baseline lake	Hardluck Creek	Twenty-Two, Twenty-Five
	Shannon-Wiever	North Goose	Baseline Lake, Sakwamatau, Goodwin lake	Hardluck Creek	Twenty-Four

Age variation is usually important in compartments that have an older area-weighted average age (Figure 2). However, compartment Alexis Reserve in W13 (W9S) and compartments Fourteen and Nineteen in W11 were the most homogeneous old compartments.

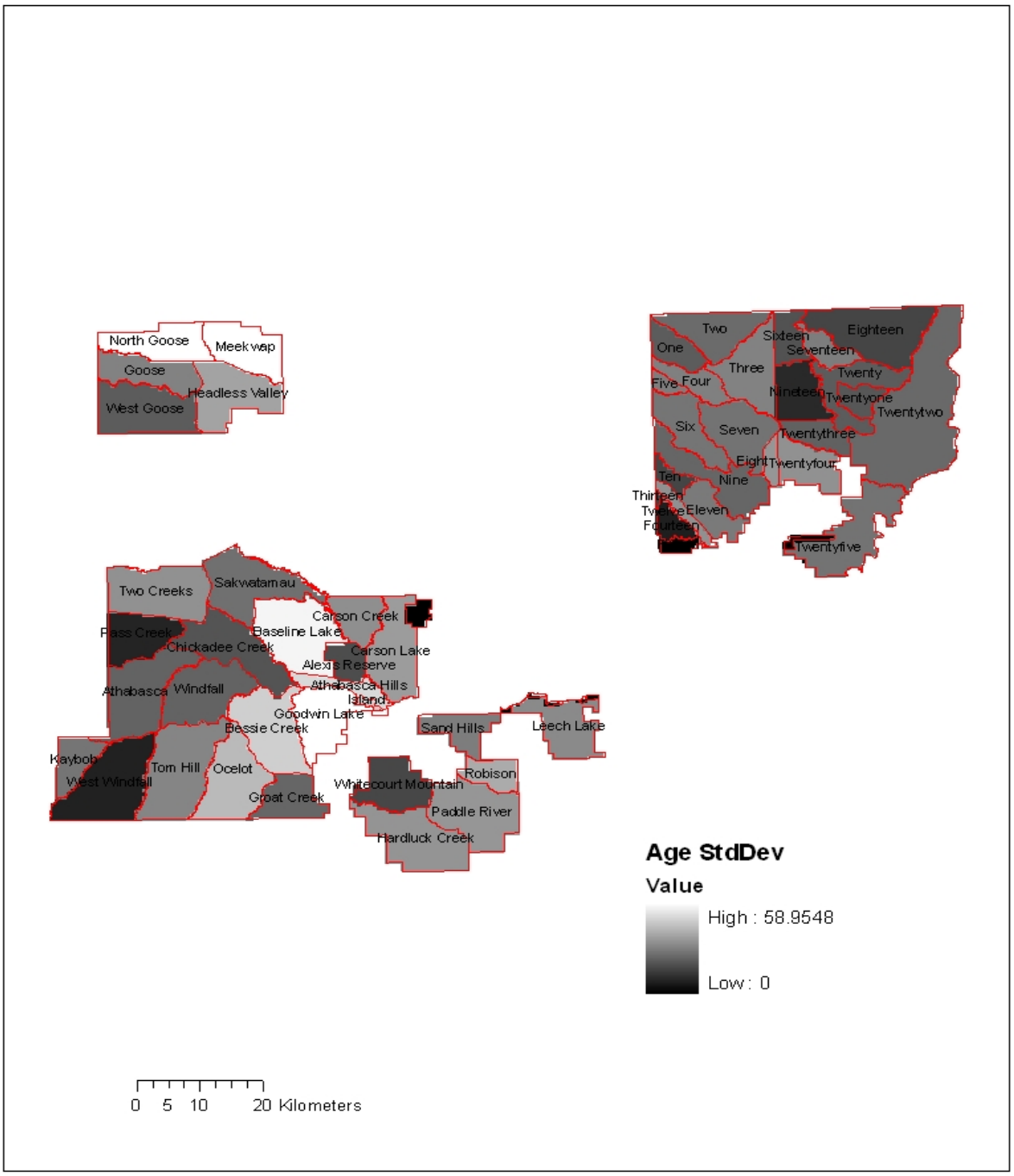

Figure 3. Area-weighted age variation of the compartments in MWFP's FMA.

Bringing both information into one graph allows us to more distinctly identify old homogeneous compartments (Figure 4).

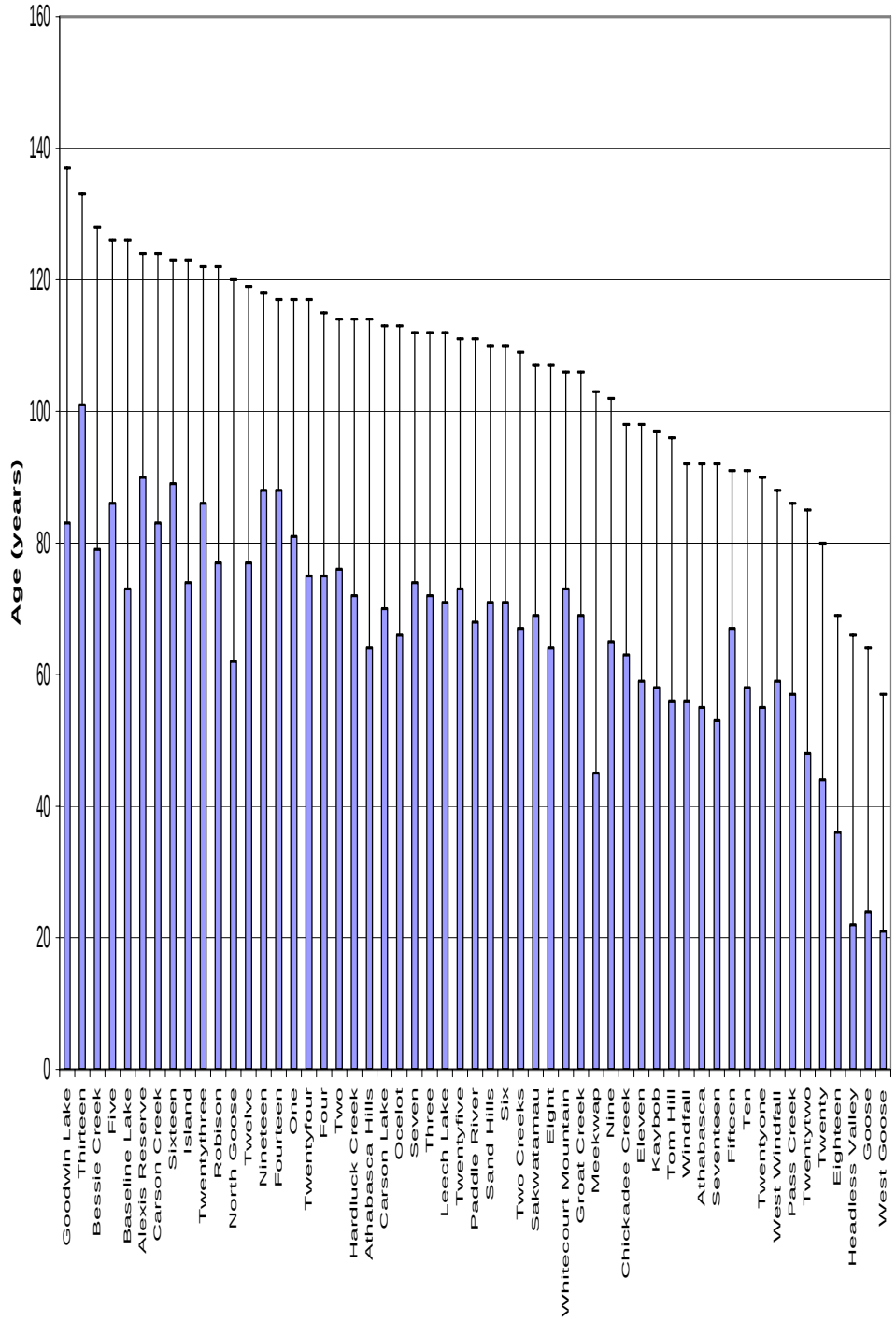

Figure 4. Age average and standard deviation by compartment in MWFP's FMA.

Old growth large tracts

We observed 14 compartments that exhibit pockets of large tracks of old growth forest (Table 1). At the scale of 1000 ha, we observe that these pockets can vary in size but are usually localized (Figure 5).

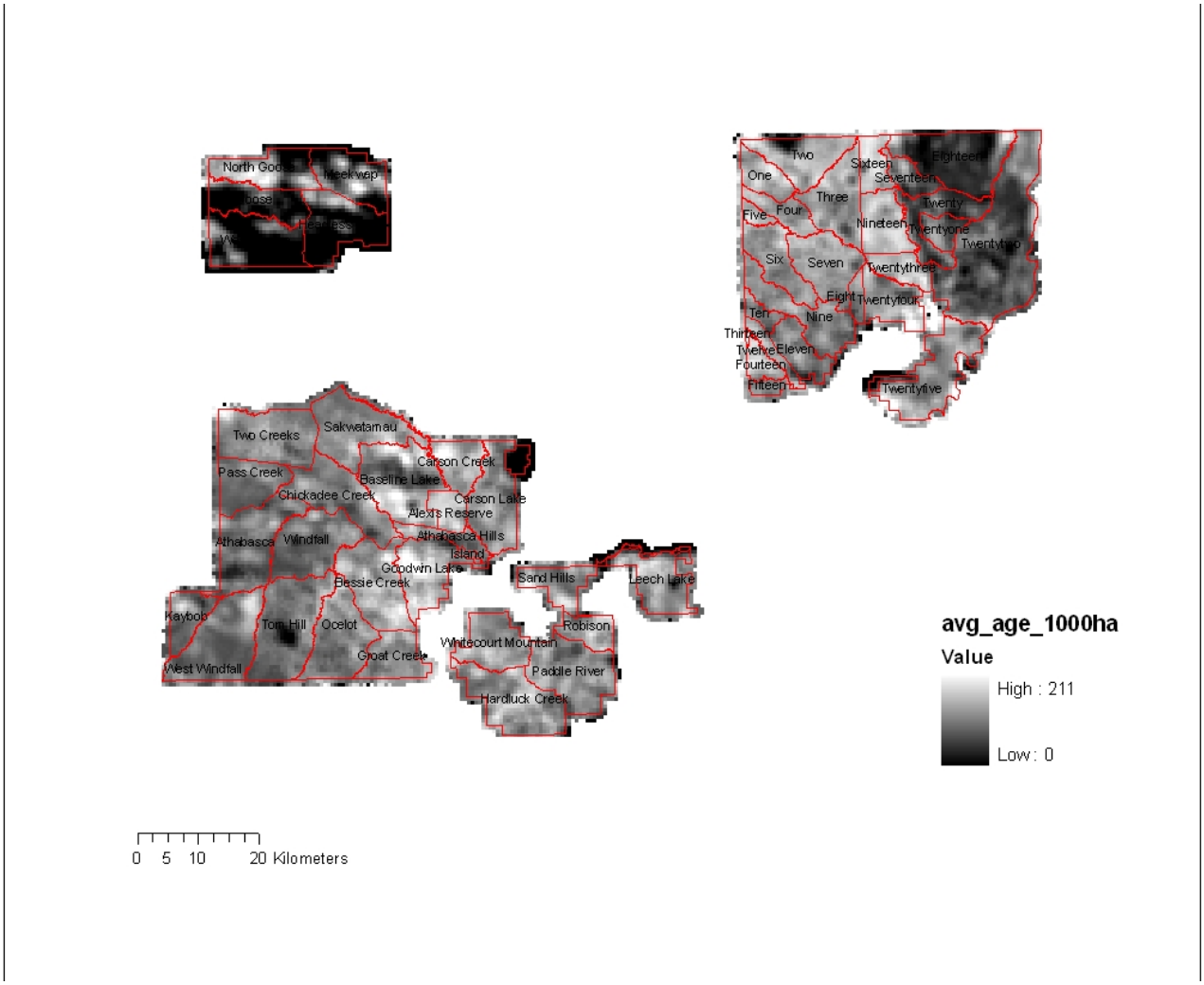

Figure 5. Average age evaluated in a 1000 ha sliding window in MWFP's FMA.

The mapping of the age standard deviation sliding window shows where age is spatially homogeneous at different scale. In Figure 6, one can see that mostly young areas are more homogeneous. However, the same compartments that were showing homogeneity in old age show pockets of homogeneous old forest (Alexis Reserve, Fourteen and Nineteen).

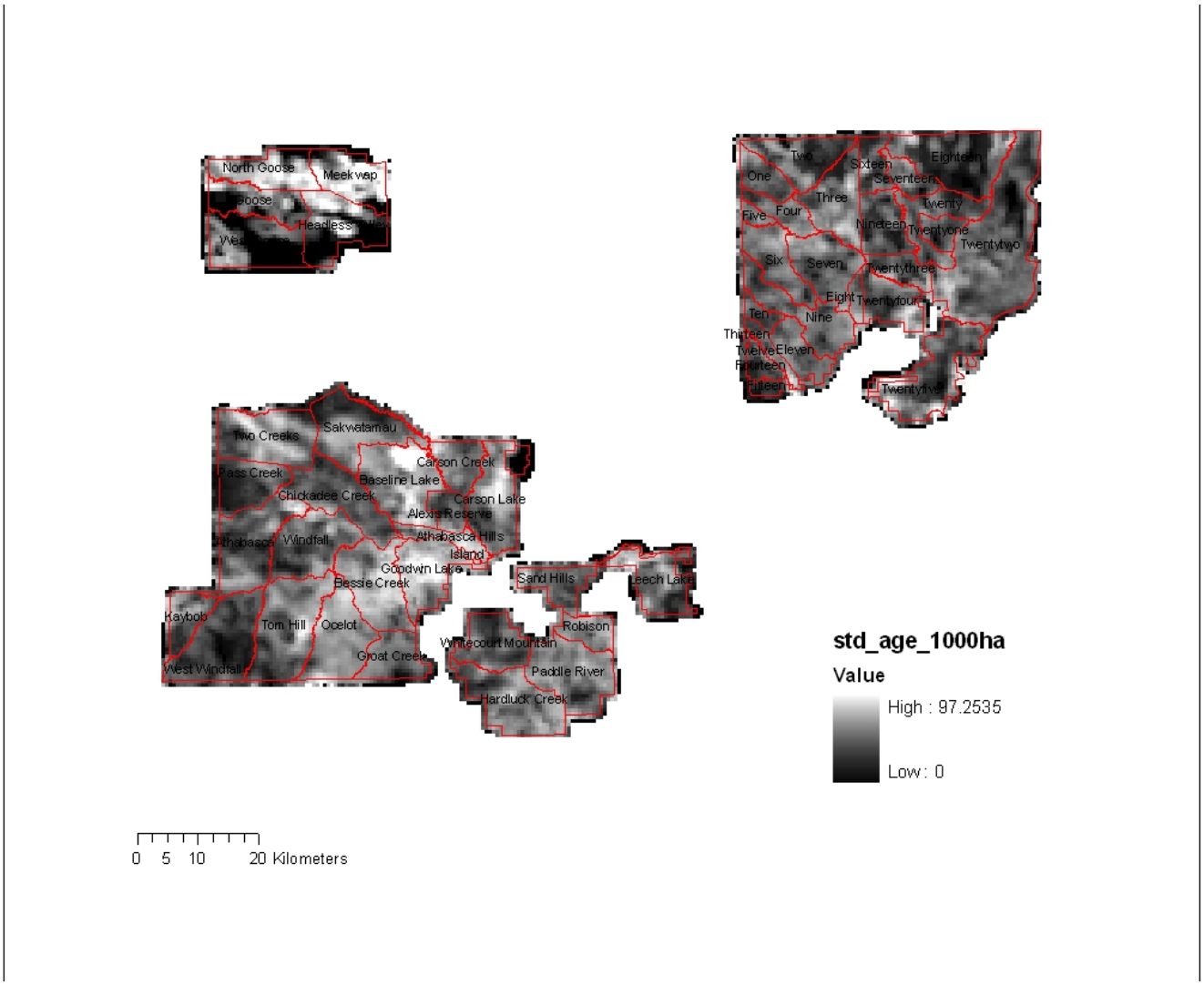

Figure 6. Standard deviation of age evaluated in a 1000 ha sliding window in MWFP's FMA.

Rarity Analysis

We identified 14 stand types that were observed in less than 10 compartments (Table 2). In W13 (W9N) the compartments that had most often rare stand types were Headless Valley and Meekwap (Table 1). In W13 (W9S), the compartment that had most often rare stand types was Baseline Lake. In W13 (W5), the compartment that had most often rare stand types was Hardluck Creek. Rare stand types were not very present in W11. When observed, they were mainly in Eleven and Twenty-Five.

Table 2. Rare stand types in MWFP's FMA.

Stand Type	D B 2	D C 3	C B 3	D D 4	DC D 4	CD A 2	C D 1	D A 3	C A 5	D C 1	C B 5	DC B 4	DC D 3	DC C 2
Number of Compartment where present	1	1	1	2	2	2	3	3	4	4	5	8	8	9

Diversity analysis

Compartments differed in terms of diversity of stand types (Table 3). In W9N. Headless Valley had the greatest richness and North Goose had the highest value for the Shannon-Wiever diversity index. In W9S, Baseline Lake was without any doubt the most diverse compartment. Sakwamatau and Goodwin Lake both ranked high in regards of the Shannon-Wiever diversity index for that FMU. In W5, Hardluck Creek was the most diverse, both by richness or Shannon-Wiever diversity index values. Finally, in general, compartments in W11 were much less diverse than in W13. The most diverse compartments of this FMU are Twenty-Two and Twenty-Five for the richness and Twenty-Four for the Shannon-Wiever diversity index.

Table 3. Richness and Shannon-Wiever diversity index in stand types for the different compartment MWFP's FMA.

FMU	Compartment	Richness	Shannon-Wiever index
W13 (W9N)	Headless Valley	51	0.929
W13 (W9N)	North Goose	49	1.216
W13 (W9N)	West Goose	46	1.020
W13 (W9N)	Meekwap	44	0.968
W13 (W9N)	Goose	43	1.022
W13 (W9S)	Baseline Lake	64	1.376
W13 (W9S)	Windfall	61	1.280
W13 (W9S)	Athabasca	59	1.295
W13 (W9S)	Two Creeks	58	1.223
W13 (W9S)	Sakwatamau	57	1.334
W13 (W9S)	Goodwin Lake	56	1.331
W13 (W9S)	Tom Hill	56	1.270

FMU	Compartment	Richness	Shannon-Wiever index
W13 (W9S)	Chickadee Creek	56	1.249
W13 (W9S)	Ocelot	55	1.219
W13 (W9S)	Carson Creek	54	1.303
W13 (W9S)	Carson Lake	54	1.293
W13 (W9S)	Bessie Creek	53	1.244
W13 (W9S)	West Windfall	50	1.014
W13 (W9S)	Athabasca Hills	49	1.223
W13 (W9S)	Pass Creek	47	1.145
W13 (W9S)	Groat Creek	46	1.190
W13 (W9S)	Alexis Reserve	41	1.267
W13 (W9S)	Kaybob	35	0.851
W13 (W9S)	Island	21	1.082
W13 (W5)	Hardluck Creek	59	1.327
W13 (W5)	Leech Lake	53	1.302
W13 (W5)	Whitecourt Mountain	49	1.070
W13 (W5)	Sand Hills	48	1.342
W13 (W5)	Paddle River	47	1.077
W13 (W5)	Robison	44	1.004
W11	Twentytwo	56	1.284
W11	Twentyfive	52	1.270
W11	Two	45	1.249
W11	Twentyfour	42	1.338
W11	Twenty	41	1.179
W11	Eighteen	39	1.061
W11	Nine	37	1.145
W11	Three	36	1.189
W11	Seven	36	1.172
W11	Sixteen	36	1.132
W11	One	35	1.103
W11	Twentythree	34	1.160
W11	Twentyone	33	1.160
W11	Seventeen	32	1.182
W11	Eleven	32	1.120
W11	Twelve	32	1.073
W11	Four	31	1.213
W11	Six	31	1.068
W11	Fourteen	30	1.073
W11	Nineteen	29	1.038
W11	Eight	27	1.110
W11	Ten	26	1.003
W11	Five	23	1.097
W11	Fifteen	18	0.816
W11	Thirteen	13	0.939

Discussion and Recommendations

When we summarize all the results from the different analysis we observed that certain compartments contribute more than others to biodiversity in the landscape (Table 1). Based on the results we obtained with the diverse biodiversity analyses at the landscape scale, we suggest the following guidelines for the compartment sequencing for harvesting:

1. At least one compartment by Forest Management Unit should be reserved in order to contribute to biodiversity. In the two large FMUs (W9S and W11), at least two should be considered and they should be spatially enough distant to each other.

2. This analysis did not look at forests outside the FMA. Spatial considerations in regards of other landscape features surrounding the FMUs might call for adjustments in the compartment ranking. For example, proximities to ecological reserves or conservation areas will required a specific landscape design and the compartment close to these areas should also be considered of special interest as they serve as first door to the FMA when dissemination from source habitats occurs. Maintaining the porosity of the matrix for movement close to theses special conservation areas should be considered mandatory.

3. Also, other land uses in this analysis were not considered. For example, grazing is known to have a strong impact on biodiversity values. The ranking of the compartment for maintaining biodiversity can be changed considering altered ecosystems by grazing in the list of high-ranked compartments for biodiversity conservation.

Considering these points, we suggest that the following compartments should be put aside for at least the next 5 years:

W13 (W9N) : Headless Valley, North Goose

W13 (W9S) : Baseline Lake, Alexis Reserve, Goodwin lake, Carson Creek, West Windfall

W13 (W5) : Hardluck Creek

W11 : Fourteen, Sixteen, Nineteen, Twenty-Five
