Rocky Mountain Forest District Partial Cutting Stocking Standards

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1. Preamble

This report has been prepared to provide recommendations for stocking standards and survey options for partial cutting silvicultural systems that have not been included in existing standards. Currently approved standards (April 10, 2003) include NDT4 sites that will be managed as open forest and open range ecosystem units. Previous meetings held in the Rocky Mountain Forest District led to agreement on two other specific types of partial cutting:

1. Current multi-storied stocking standards and procedures will be applied to standards units that have been prescribed with single-tree selection silvicultural systems; and,

2. Beetle-proofing treatments in lodgepole pine dominated stands should be treated as intermediate cuts with a specific target range of post-harvest stand structures. Figure 2 has been prepared for consideration; it uses a stocking chart (after Gingrich 1967) to display the suggested range of acceptable post-harvest stand structure for beetle-proofed lodgepole pine stands.

The remainder of this report outlines a set of standards and an approach for assessing regeneration and free-growing success for other types of partial cutting.

2. Additional Partial Cutting Stocking Standards

The following proposed approach to defining and assessing stocking success in partial cut standards units apply to even-aged silvicultural systems that have retained a minimum of five (5) m^2/ha of residual basal area. Recommended stocking decisions are based on management objectives that are focussed toward the production of sawlog timber. Bancroft *et. al.* (2003) and Martin (2004) have completed the initial work associated with the "Deviation From Potential" approach to assessing stocking in complex partially cut stand structures; their work has been incorporated into this proposed approach for the Rocky Mountain Forest District.

NOTE: It is important to remember that some of the residual structures that would be accepted using this approach for stocking assessment are below stocking levels that would promote optimal growth where sawlog timber production is the dominant management objective. In many cases, they are intermediate cuts in a silvicultural system. These structures will result in growth losses, relative to TSR expectations, if they are retained for extended periods (Przeczek 2002).

Non-timber values that require a partial cutting treatment to achieve short term management objectives (0 – 20 years) will result in stand structures that are appropriate for the use of these standards. **The expectation in these standards units is that additional harvesting with follow-up regeneration treatments will be required in the 20 – 30 year period if base case TSR volume assumptions are to be attained.** If additional harvesting that will promote close to optimal sawlog growth rates does not occur, TSR base case assumptions will need modification.

Where non-timber management objectives require the long-term retention of residual structures that are below the minimum stocking line(s) in Figure 3, unique standards should be submitted to the District Manager for approval through a FDP (FSP) amendment.

3. Assessment Procedures

Plot assessments will be conducted as per standard even-aged regeneration and free-growing assessments with the following change:

3.1 Layer 1 stems (≥ 12.5 cm dbh)

Tally stems by species and diameter class (5 or 10 cm classes are appropriate) using an appropriate prism. Initial indications suggest that a 3 - 5 BAF prism will provide reasonable data for most sites. Tally dead and moribund trees as separate classes (species) but do not include them in basal area summaries for the stand. It will also be necessary to tally acceptable and unacceptable layer 1 stems separately because the minimum stocking line decision is based on acceptable layer 1 stems and the DFP stocking decision requires = 80% of the layer 1 stems to be of acceptable quality; the deviation from potential (DFP) calculation for each plot is based on all layer 1 stems (except for dead and moribund). The more intensive tally of BA will assist with the determination of DFP until surveyors and practitioners become familiar with the system. It will also help with the preparation of more detailed treatment prescriptions where additional overstory manipulation will be required (e.g., harvesting).

3.2 Data Compilation

In addition to standard regeneration survey summary information, the following are required:

1. For the minimum stocking line, compute basal area, density, and mean diameter of live acceptable L1 trees.

2. Basal area (m^2) and well-spaced sph for each plot will be compared to Table 1 and the DFP will be recorded. The mean DFP will be calculated for each stratum along with the proportion (%) of stocked, partially stocked and open plots[1]; and,

3. A stand table (m^2/ha) could be prepared for each stratum to assist with decision making but it is not a survey requirement at this time.

4. Decision Rules

Stocking decisions will be based on the flow chart provided in Figure 1. Figure 3 should be consulted when assessing stocking in these partially cut stands. It uses density (sph), basal area (m^2/ha), and isolines of average stand diameter (after Gingrich 1967) as the basis for displaying:

1. Minimum Stocking Line

   This line represents the lowest residual stocking level of acceptable layer 1 stems (≥ 12.5 cm dbh) that will be considered stocked. If average stocking in a standards unit meets or exceeds the minimum stocking line the SU will be considered SR or FG (if all other species selection, health, size, and damage criteria are met). Two minimum

[1] NOTE: the % of plots calculation is a surrogate for the % of area. If the proportion or distribution of plots does not reflect the area for each DFP stocking class the calculation will be incorrect and another approach to estimating proportional area will have to be documented and applied.

stocking lines are presented; one for sites with 700/1200 even-aged stocking standards and one for sites with 500/1000 even-aged stocking standards.

The deviation from potential stocking (DFP) should also be assessed to ensure that the majority of the standards unit is acceptably stocked (≥ 60% of the area as determined by the % of plots).

2. Lower Basal Area Limit

   This line defines the lowest average residual basal area, including all layer 1 stems, (≥ 5 m^2/ha) that a standards unit is allowed for the application of this approach to stocking assessment. Standards units with residual basal areas < 5 m^2/ha should be assessed with current even-aged stocking standards.

3. Deviation From Potential Stocking Zone

   This area of the diagram represents the range of residual stand structures that will require the application of the DFP approach to assessing stocking and free-growing status.

Table 1. Deviation from potential (DFP) volume by understory tree density and overstory basal area.

OS Basal Area	Well-spaced trees in plot								
(m2/ha)	0	1	2	3	4	5	6	7	8
0	1.00	0.76	0.52	0.34	0.22	0.13	0.07	0.03	0.00
1	0.98	0.74	0.51	0.34	0.21	0.13	0.07	0.03	0.00
2	0.96	0.73	0.50	0.33	0.21	0.13	0.07	0.03	0.00
3	0.93	0.71	0.49	0.32	0.20	0.12	0.07	0.03	0.00
4	0.90	0.68	0.47	0.31	0.20	0.12	0.06	0.03	0.00
5	0.86	0.65	0.45	0.30	0.19	0.11	0.06	0.02	0.00
6	0.82	0.62	0.43	0.28	0.18	0.11	0.06	0.02	0.00
7	0.77	0.58	0.40	0.27	0.17	0.10	0.05	0.02	0.00
8	0.72	0.55	0.38	0.25	0.16	0.09	0.05	0.02	0.00
9	0.67	0.51	0.35	0.23	0.15	0.09	0.05	0.02	0.00
10	0.62	0.47	0.32	0.21	0.14	0.08	0.04	0.02	0.00
11	0.57	0.43	0.30	0.20	0.12	0.07	0.04	0.02	0.00
12	0.52	0.39	0.27	0.18	0.11	0.07	0.04	0.01	0.00
13	0.47	0.35	0.24	0.16	0.10	0.06	0.03	0.01	0.00
14	0.42	0.32	0.22	0.15	0.09	0.05	0.03	0.01	0.00
15	0.38	0.28	0.20	0.13	0.08	0.05	0.03	0.01	0.00
16	0.33	0.25	0.17	0.11	0.07	0.04	0.02	0.01	0.00
17	0.29	0.22	0.15	0.10	0.06	0.04	0.02	0.01	0.00
18	0.26	0.19	0.13	0.09	0.06	0.03	0.02	0.01	0.00
19	0.22	0.17	0.12	0.08	0.05	0.03	0.02	0.01	0.00
20	0.19	0.14	0.10	0.07	0.04	0.02	0.01	0.01	0.00
21	0.16	0.12	0.08	0.06	0.04	0.02	0.01	0.00	0.00
22	0.13	0.10	0.07	0.05	0.03	0.02	0.01	0.00	0.00
23	0.11	0.08	0.06	0.04	0.02	0.01	0.01	0.00	0.00
24	0.09	0.07	0.05	0.03	0.02	0.01	0.01	0.00	0.00
25	0.07	0.05	0.04	0.02	0.02	0.01	0.00	0.00	0.00
26	0.05	0.04	0.03	0.02	0.01	0.01	0.00	0.00	0.00
27	0.04	0.03	0.02	0.01	0.01	0.00	0.00	0.00	0.00
28	0.02	0.02	0.01	0.01	0.01	0.00	0.00	0.00	0.00
29	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00
30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Colour

Stocking Class

Growth Potential Opportunity

Open

High potential for additional volume growth

≥ 41% Additional stocking is required where timber production is the primary management objective

Partially Stocked

Moderate potential for additional volume production through additional stocking

21 – 40% Assess options, additional stocking may be required

Stocked

Low potential for additional growth through additional stocking

≤ 20% No further treatments required

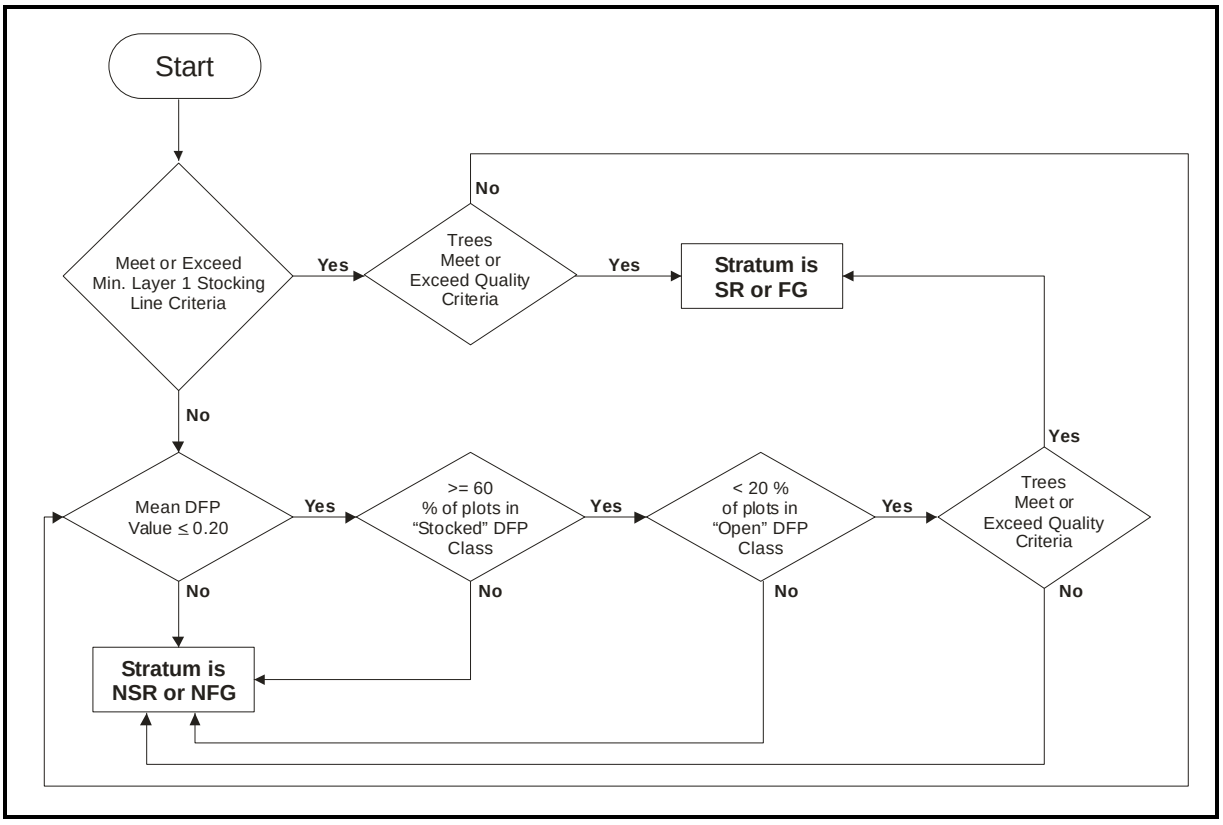

Figure 1. Stocking decision flowchart.

Notes: Many of these stands will have clumped, irregular stocking patterns and the amount of overstory will limit the potential for augmenting stocking through planting. All NSR openings ≥ 1.0 ha, that are not under significant overstory influence, should be reforested.

There may be a limited biological or financial opportunity to increase stocking in some partially cut stands that do not meet the stocking criteria. However, these strata cannot be declared stocked or free-growing; additional harvesting treatments may be required before stocking levels in layer 4 can be augmented.

5. Proposed Standards

5.1 Minimum Stocking Line, DFP, and General Criteria

Table 2 and Table 3 provide a set of proposed standards for partial-cutting in the Rocky Mountain Forest District. The standards should be applied to partially cut standards units that were not prescribed for single-tree silvicultural systems, NDT4 ecosystem restoration (open forest or open range), beetle-proofing in lodgepole pine dominated stands, or where management objectives require long term overstory retention and where a reduction in yield is acceptable. These standards should be viewed as a First Approximation and they will be revised as more experience is gained with the system and as better information becomes available.

Table 2. Proposed minimum partial-cutting stocking standards for site series with 700/1200 even-aged stocking standards, for the Rocky Mountain Forest District.

Minimum Stocking Line Criteria			Deviation from Potential (DFP) Criteria			General Criteria			
Average DBH (cm)[1]	MSS Density (sph)	MSS Basal Area (m^2/ha)	Maximum Mean DFP	Maximum % Partially Stocked Plots	Maximum % Open Plots	Min. Intertree Distance[2]	Regen. Delay (max. yrs.)[3]	FG Earliest (yrs.)[3]	FG Latest (yrs.)[3]
< 12.5			0.20	40	20	n/a + 2.0	1	1	2
15	560	10							
20	480	15							
25	360	17							
30	280	20							
35	210	20							
40	180	20							
45	150	20							
50 - 60	100	20							

Notes:

1. Calculation is based on stems ≥ 12.5 cm dbhob; Average DBH is the weighted average for all acceptable stems.
2. No minimum intertree will be applied to layer 1 stems; a 2.0 minimum intertree distance will apply to layer 2, 3, and 4 stems.
3. Timeframes only apply where a stratum is declared SR or FG using the minimum stocking line and were chosen to allow up to 2 years for assessing windthrow damage prior to a free-growing declaration. If the minimum stocking line is not used, time frames will default to even-aged regeneration delay and free-growing delay periods.

Table 3. Proposed minimum partial-cutting stocking standards for site series with 500/1000 even-aged stocking standards, for the Rocky Mountain Forest District.

Minimum Stocking Line Criteria			Deviation from Potential (DFP) Criteria			General Criteria			
Average DBH (cm)[1]	MSS Density (sph)	MSS Basal Area (m^2/ha)	Maximum Mean DFP	Maximum % Partially Stocked Plots	Maximum % Open Plots	Min. Intertree Distance[2]	Regen. Delay (max. yrs.)[3]	FG Earliest (yrs.)[3]	FG Latest (yrs.)[3]
< 12.5			0.20	40	20	n/a + 2.0	1	1	2
15	440	8							
20	400	12.5							
25	290	14							
30	200	14							
35	150	14							
40	110	14							
45+	90	14							

Notes:

1. Calculation is based on stems ≥ 12.5 cm dbhob; Average DBH is the weighted average for all acceptable stems.
2. No minimum intertree will be applied to layer 1 stems; a 2.0 minimum intertree distance will apply to layer 2, 3, and 4 stems.
3. Timeframes only apply where a stratum is declared SR or FG using the minimum stocking line and were chosen to allow up to 2 years for assessing windthrow damage prior to a free-growing declaration. If the minimum stocking line is not used, time frames will default to even-aged regeneration delay and free-growing delay periods.

5.2 Tree Acceptability Criteria

Table 4 provides a summary of the standards for tree acceptability for regeneration and free-growing assessments.

Table 4. Tree acceptability criteria for the proposed stocking assessment procedure.

Tree Acceptability Criteria	Regeneration Assessment	Free-growing Assessment
Species	All layer 1 stems will be considered as preferred species. Preferred and acceptable species for the site as per current even-aged stocking standards for other layers.	All layer 1 stems will be considered as preferred species. Preferred and acceptable species for the site as per current even-aged stocking standards for other layers.
MSS_p	Preferred species $\geq$ 50% of the well-spaced stocking	Preferred species $\geq$ 50% of the free-growing stocking
Health	Healthy	As per free-growing damage criteria (ETFG Guidebook, Appendix 5) and the Tree Wounding Guidebook. In stands that do not meet or exceed the minimum stocking line, = 80% of the TOTAL Layer 1 stems must be of acceptable quality.
Brush		Appropriate conifer/brush ratio (ETFG Guidebook, Appendix 9)
Height	Min. 30 cm	65% of the minimum free-growing height for the species and site
Advanced Regeneration		Advanced regeneration standards (ETFG Guidebook, Appendix 10)
Minimum Intertree Distance	2.0 m, no MITD for layer 1 stems	2.0 m, no MITD for layer 1 stems

6. References

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Martin, Pat. 2004. *Second approximation of the deviation from potential table*. Unpubl. Information Sheet. 17pp.

Przeczek, John E. 2002. *Partial Cutting Effects Study: Modeling with Prognosis^{BC} and TASS to Assess Partial Cutting Impacts on Yield in the Invermere T.S.A.*. Unpubl. FIA Rep. for Slocan Forest Products Ltd. and Tembec Industries Ltd. 21 pp. + append.

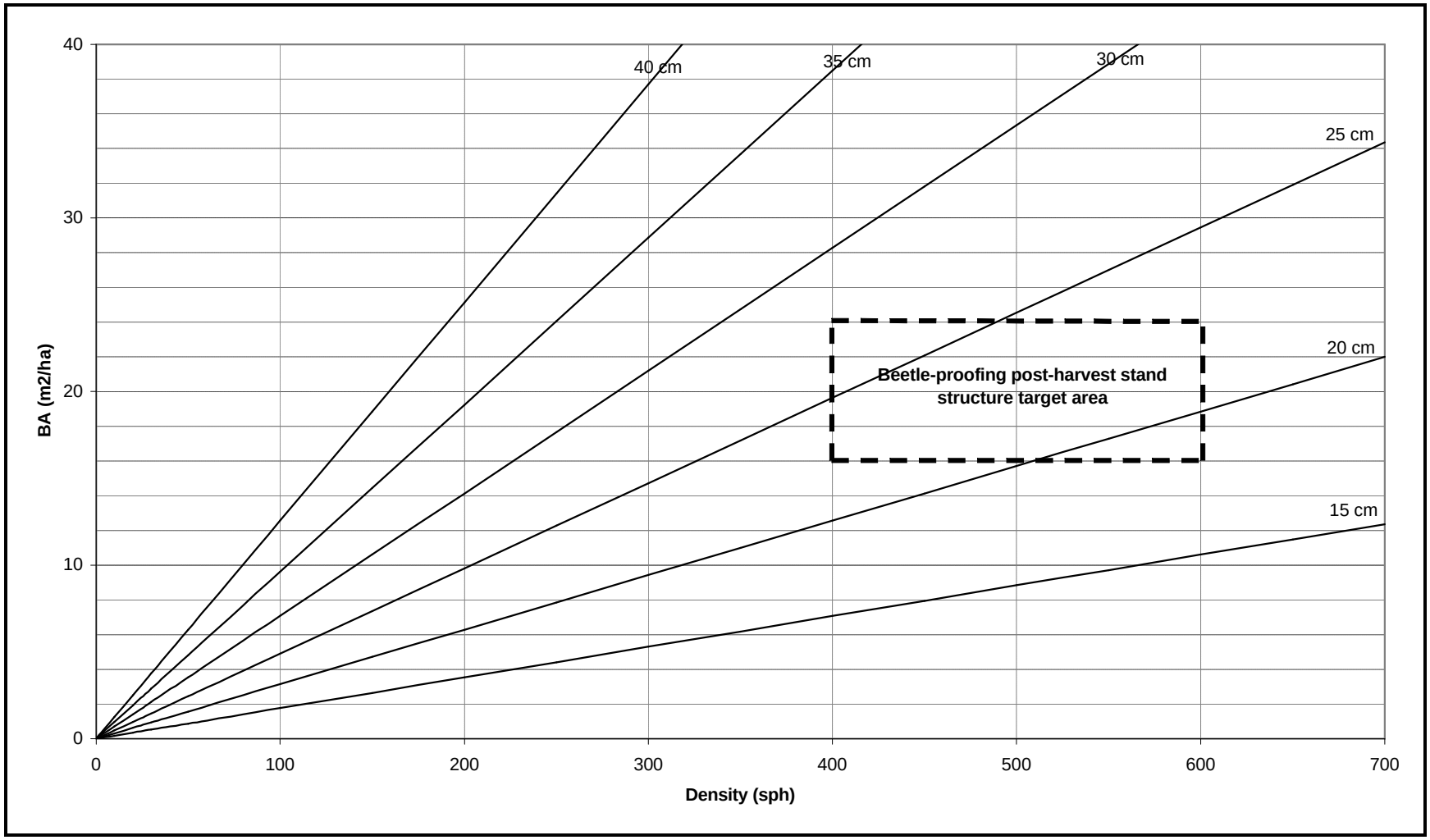

Figure 2. Suggested post-harvest stand structure standards for beetle-proofed lodgepole pine stands in the Rocky Mountain Forest District.

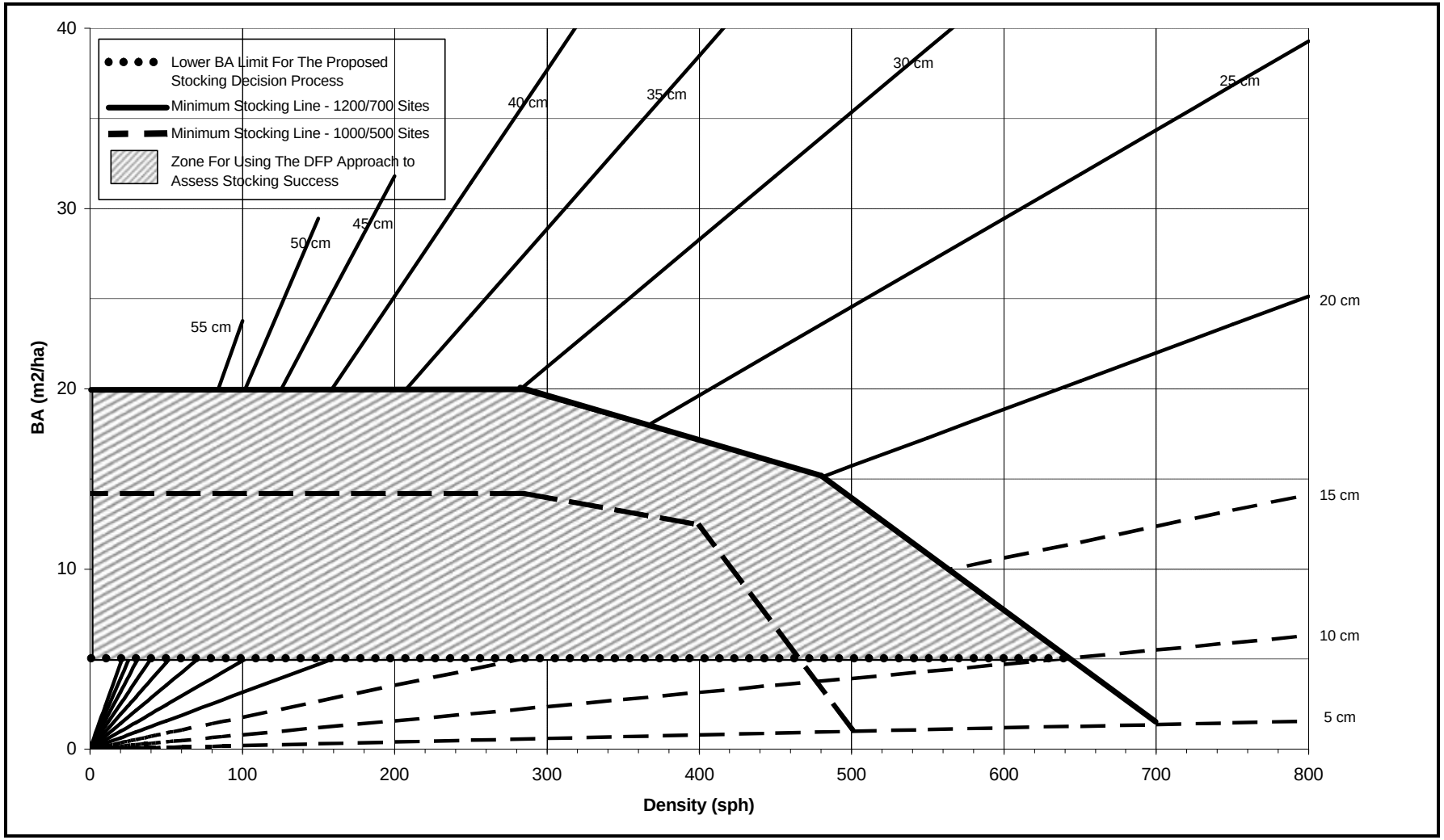

Figure 3. Stocking zone, lower basal area limit, minimum stocking line, and isolines of average stand diameter for assessing partial cut stands in the Rocky Mountain Forest District