United States Department of Agriculture

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WOODLAND/FORESTRY TECHNICAL NOTE NO. NM 41

SUBJECT: ECS – D + X SPACING GUIDE AND BASAL AREA CONVERSION TABLES FOR PONDEROSA PINE

Effective Date: Effective when received.

Purpose: The attached document is intended to assist the planner who prefers using D + X spacing guides and to assist in making conversions between basal area, trees per acre, approximate spacing, and D + X.

Background: The first and second tables were produced by the forester of the Western Regional Technical Service Center to show the planner appropriate D + X spacing for trees found in New Mexico based on shade tolerance and site index. The second table shows recommended basal area stocking rates (in square feet per acre) for ponderosa pine as they compare to D + X spacing recommendations, stems per acre, and spacing. The final graph was created by the staff forester of New Mexico as a more visual representation of the correlation between BA, trees per acre, and D + X. It is intended to roughly mimic the Gingrich Stocking Diagrams (Gingrich, S.F. 1967). However, not enough data is currently available to draw overstocked and understocked curves on the chart to create New Mexico specific stocking diagrams.

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State Resource Conservationist

TECHNICAL NOTE
D + X SPACING GUIDE AND BASAL AREA CONVERSION TABLES FOR PONDEROSA PINE

D + X is best applied to pure stands under even-aged management with the goal of timber production. The inventory method directly correlated to D+X spacing is the zig-zag transect, explained in Section 636.21 (Forest Inventory) of the National Forestry Manual. D + X may also be used, with conversion tables, with inventories using fixed and variable radius plots. Once basal area and diameter measurements are obtained from fixed and variable radius plots, average diameter can be calculated, trees per acre can be calculated, and a D + X spacing can be calculated using the tables below. If a planner intends to use D + X spacing to guide management, site index measurements must be taken, and then Table 1A and 1B can be used to identify average spacing recommendations.
For ponderosa pine stands, tables 2 and 3 can be used to show how basal area, D + X, trees per acre, and average stand diameter correlate.

TABLE 1A. GENERAL "D+X" THINNING SPACING GUIDE

For a tree story ≥ 10" average dbh, D = existing average dbh.
For a tree story ≤ 9" average dbh; D = the planned future dbh.

Species Groups (and site index ranges; L=lower, M=mid, U=upper))	**Additional Requirements:**	***Average Spacing between Trees (in feet)***	
		Thin to:	***Thin again when:***
Very shade tolerant *Subalpine fir/corkbark fir* *(L<55; M 55-80; U>80)* *White fir* *(L<65; M 65-90; U>90*	1. For small diameter stands (existing average dbh ≤ 9") use the specified planned future dbh (usually 10, 11, or 12" dbh) in combination with the "thin again when" D+X spacing to determine planned average spacing (feet). 2. For species having published site index curves, use the bounds of spacing (constants are underlined) shown in the two columns to the right for mid-range sites (middle one-third of the site index range). For highest or best sites (upper one-third) subtract one foot from the constants. For the lowest sites (lower one-third), add one foot to the constants, respectively. 3. After the adjustment for site index, add +1 or +2 feet to the constants if the site has or can grow significant understory	***D+4***	***D+1***
Shade tolerant *Engelmann spruce* *(L<55; M 55-80; U>80)*		***D+5***	***D+2***
Somewhat shade tolerant *Blue spruce* *(L<55; M 55-80; U>80)*		***D+6***	***D+3***
Shade intolerant *Douglas-fir (interior)* *(L<55; M 55-80; U>80)* *Ponderosa pine*		***D+7***	***D+4***

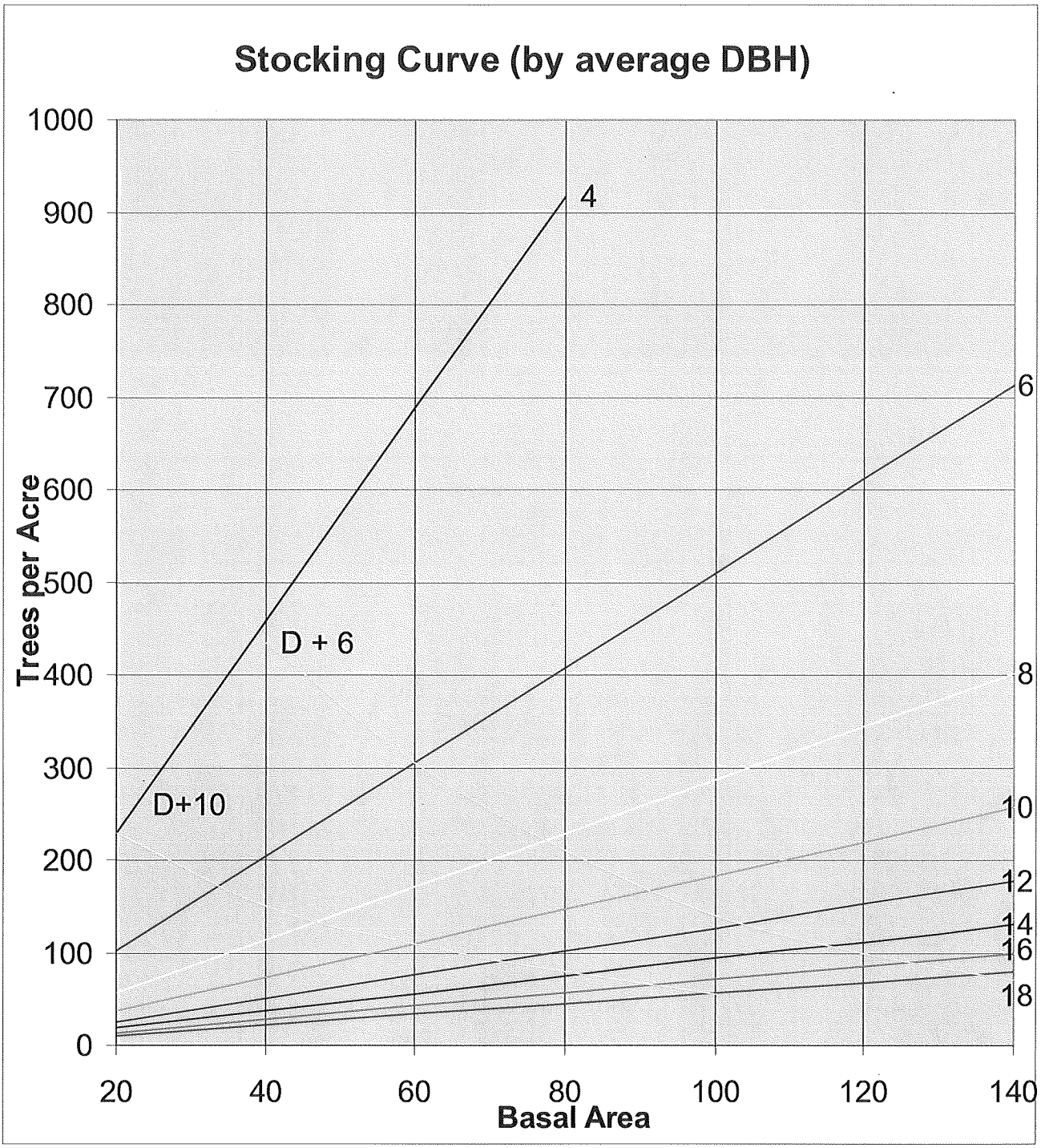
(L <70; M 70-100; U >100) *Limber pine/SW white pine* *(L< ,M , H>)* *Aspen* *(L<45; M 45-75; U>75)*	forage and browsing resources that are or will be used by animals. 4. Consider thinning over-stocked stands in two or three stages if there is a potential for snow or wind breakage or blowdown. This will provide tree-to-tree support while crowns and root systems grow and strengthen. 5. Use table 1b to convert average spacing between trees to stems per acre. Enter spacing and stems/acre in the table in the job sheet for the "planned" columns.		
Very shade intolerant *Lodgepole pine* *(L<55; M 55-80; U>80)* *Pinyon* *(L<50; M 50-100; U>100)* *Juniper* *(L<50; M 50-100; U>100)*		***D+8***	***D+5***

Table 1b. Average Spacing (feet) and Trees/Acre

Spacing	Trees/ac.	Spacing	Trees/ac.	Spacing	Trees/ac.	Spacing	Trees/ac.
3	4840	**14**	222	**25**	70	**36**	34
4	2723	**15**	194	**26**	64	**37**	32
5	1742	**16**	170	**27**	60	**38**	30
6	1210	**17**	151	**28**	56	**39**	29
7	889	**18**	134	**29**	52	**40**	27
8	681	**19**	121	**30**	48	**50**	17
9	538	**20**	109	**31**	45	**60**	12
10	436	**21**	99	**32**	43	**70**	9
11	360	**22**	90	**33**	40	**80**	7
12	303	**23**	82	**34**	38	**90**	5
13	258	**24**	76	**35**	36	**100**	4

Table 2. Target Basal Areas and Equivalent Stems/acre, Average Spacing, and D+X Values for Ponderosa Pine				
If desired basal area (ft^2) is:	**and average stand DBH (inches) is:**	**the residual stems/acre would be:**	**the average spacing (feet) of residual stems would be:**	**the D+X value would be:**
40	4	458	10	6
	6	204	15	9
	8	115	19	11
	10	73	24	14
	12	51	29	17
	14	37	34	20
	16	29	39	23
	18	23	44	26
	20	18	49	29
	22	15	54	32
	24	13	58	34
	26	11	63	37
60	4	688	8	4
	6	306	12	6
	8	172	16	8
	10	110	20	10
	12	76	24	12
	14	56	28	14
	16	43	32	16
	18	34	36	18
	20	28	40	20
	22	23	44	22
	24	19	48	24
	26	16	52	26
80	4	917	7	3
	6	407	10	4
	8	229	14	6
	10	147	17	7
	12	102	21	9
	14	75	24	10
	16	57	28	12
	18	45	31	13
	20	37	34	14
	22	30	38	16

	24	25	41	17
	26	22	45	19
100	4	1146	6	2
	6	509	9	3
	8	286	12	4
	10	183	15	5
	12	127	18	6
	14	94	22	8
	16	72	25	9
	18	57	28	10
	20	46	31	11
	22	38	34	12
	24	32	37	13
	26	27	40	14
120	4	1375	6	2
	6	611	8	2
	8	344	11	3
	10	220	14	4
	12	153	17	5
	14	112	20	6
	16	86	23	7
	18	68	25	7
	20	55	28	8
	22	45	31	9
	24	38	34	10
	26	33	37	11


Stocking Curve (by average DBH)
Trees per Acre
1000
900
800
700
600
500
400
300
200
100
0
20
40
60
80
100
120
140
Basal Area
4
6
8
10
12
14
16
18
D + 6
D+10