		loodpla	in Fores	t		N	let Fore	st		Forested Rich Peatland									Acid Peatland	
Floristic Region	Nort	hern	Sout	hern	Northern N			NW	SO	Northern NW SC						SO	SO Northern			
	FFn57	FFn67	FFs59		WFn53					FPn62	FPn63	FPn71		FPn81	FPn82	FPw63	FPs63	APn80		
Quaking aspen	-				9d	2 d	3d	1 d									-			
Jack pine																			<u> </u>	
Red pine																			<u> </u>	
White pine						12d				-			-		-				3wd	
White spruce	-				6d	15d	-	4		-			-				5d		Ļ	
Northern pin oak																			<u> </u>	
Black cherry																			<u> </u>	
Red cedar																				
Black oak																				
Shagbark hickory																				
Basswood	3wd		6d			10 wd			2wd											
Paper birch	8 d				3d	8d	7d	6d	5d	3wd	5wd		3wd				3d		-	
Sugar maple			13d			-			3wd											
Northern red oak									-											
Red maple						6wd	6wd										-			
Bur oak	5wd	6wd	14d			14wd			8wd											
Ironwood																				
Big-toothed aspen																				
White oak									-											
Bitternut hickory			12 w																	
Butternut]				
Silver maple	1w	1 w	1w	1w																
American elm	6w	4wd	2w	4wd		11wd	8wd	8w	6w				-							
Green ash	4w	2wd	9w	2wd		5wd			7w											
Box elder	7w	5wd	4w	6wd					10w											
Red elm			11w				10wd		9w											
Hackberry			7w	8wd																
Cottonwood			3w	3w																
Black walnut			10w																	
Swamp white oak			5w	7wd																
River birch				5d																
Rock elm			15w																	
White cedar					1	4	4			4	1	3d			3d					
Balsam fir	9				4d	9d	9d	5		5d	- 3d					İ	4d			
Balsam poplar					7d	7d		2							İ	İ				
Black ash	2	3	8		2w	1w	1w	3w	1				-			-				
Yellow birch					8wd	3wd	5wd		4							1				
Tamarack					-	-	2	7		2	4	2	1	1	1	1	1	2	2	
Black spruce					5	13				1	2	1d	2	2 d	2d	2	2	1d	1d	

Suitability of Tree Species by Native Plant Community (NPC)

Purpose

These tables are intended to help foresters decide which tree species to silviculturally favor or introduce on sites that have been classified using the *Field Guides to the Native Plant Communities of Minnesota*¹. Trees with excellent suitability should grow well with very little silvicultural treatment other than providing the correct light and seedbed environments for establishment and recruitment. Trees with poorer suitability for a site can be grown to meet specific objectives, but the forester should expect progressive increases in cost and risk for trees with good to fair to poor suitability rankings. The underlying assumption for using these tables is that when trees are naturally suited to their site, they are vigorous. Vigor should translate to superior quality, resistance to disease, capacity for natural regeneration, and the ability to withstand fluctuations in climate.

Suitability Index

Suitability is a mathematical calculation. The data for this calculation come from 4,414 vegetation plots that have been classified as belonging to one of 52 forested NPCs. Two metrics -- commonness and local abundance -- are the elements of suitability.

A plant is "suited" to a NPC when we often find it there. Percent presence was our metric of commonness. Similarly, a plant is "suited" to a NPC when it tends to occur in abundance when present. Mean percent cover-when-present was our metric of local abundance. *The suitability index is the product of percent presence and mean percent cover-when-present*.

Using the Tables

What the Colors Mean -- trees compared to all plants

Cell colors indicate whether a tree would be an excellent, good, fair, poor, or very poor choice as a crop tree. A tree's assignment to one of these classes was based upon its suitability index when compared to the index of all other common plants in that community.

Example: For the MHn35 community, there were 113 plants with >5% presence. The suitability index of each plant was placed in a table and the table sorted to rank plants by their index. The ranking was segregated into 4 groups of 23 plants each and a final class of 21 plants. The group of 23 plants with the highest indices were assigned excellent suitability, the next 23 plants were assigned good suitability, etc. Basswood had the 8th highest ranking, placing it in the excellent class along with 22 other plants.

What the Numbers Mean -- trees compared to other trees

The cell numbers indicate a tree's suitability index ranking as compared to all other trees. A tree with the number 1 is considered the tree most suited to that NPC.

Example: For the MHn35 community, sugar maple trees had the second highest ranking overall and the highest ranking among all trees, so a 1 appears in the cell. Basswood had the eighth overall ranking, which was the second highest ranked tree, so a 2 appears in the cell.

Example: Of the 4,414 sample plots, 256 were classified as Northern Mesic Hardwood Forest (MHn35). Basswood trees occur in 164 of the 256 plots. Thus, its percent presence as a tree is (164/256)*100= 64.1%. The mean cover of basswood trees on those 164 plots is 15.0%. Thus, its suitability index is 64.1*15.0=962.

Climate Shift Calculations

Due to global warming, land managers are bracing for local vegetation shifts to plants whose North American ranges are warmer and drier than their habitat in Minnesota². An analysis of range climate was used to assign³ and adjust⁴ "synecological" scores for our plants with regard to moisture (M) and temperature (H). The scores range from 1 (dry/cool) to 5 (wet/ warm). The difference between a plant's individual synecological score and the mean synecological score of its community provides some insight as to whether that plant would benefit or or suffer should its local environment become warmer or drier.

Example: For each of the 256 MHn35 vegetation plots, the M score of all component plants was summed and averaged to yield a score for each plot. Then the plot scores were summed and averaged to yield an M score for the community, which in this case was 2.3. The adjusted M score for basswood is 2.01, which is drier than 2.3. Thus, we assume that basswood would benefit from a slightly drier conditions. Similarly, the H score for basswood is 4.03, which is substantially warmer than the 2.9 mean for the MHn35 community ... suggesting that basswood would greatly benfit if MHn35 sites get warmer.

What the Letters Mean -- tree affinity for warmer or drier site conditions For each tree the a lower-case "w" follows the tree ranking when that tree has a warmer synecological score than the average for the community. A lower-case "d" follows the the tree ranking if it has a drier synecological score than the community mean.

Example from MHn44 Community									
Quaking aspen	1d	excellent rating; 1st ranked; favored if habitat gets drier, disfavored if warmer							
White cedar	7	good rating; 7th ranked; disfavored if habitat gets warmer and/or drier							
Sugar maple	13wd	fair rating; 13th ranked; favored if habitat gets warmer and/or drier							
Green ash	14w	poor rating; 14th ranked; favored if habitat gets warmer, disfavored if drier							
American elm		very poor rating; occurs in trace amounts; ranking and climate shift not presented							
Jack pine		not known to occur in MHn44, no calculations possible							

 Minnesota Department of Natural Resources (2003, 2005, 2005). Field Guide to the Native Plant Communities of Minnesota. Ecological Land Classification Program, Minnesota County Biological Survey, and Natural Heritage and Nongame Research Program. MNDNR St. Paul, MN.

- 2. Minnesota Department of Natural Resources (2011). Climate Change and Renewable Energy: Management Foundations. Climate and Renewable Energy Steering Team. MNDNR St. Paul, ,MN.
- Bakuzis, E.V. and Kurmis, V. 1978. Provisional list of synecological coordinates and selected ecographs of forest and other plant species in Minnesota. Staff Series Paper 5. Department of Forest Resources, University of Minnesota. St. Paul, MN, US.
- 4. Brand, G.J., and Almendinger, J.C. 1992. Synecological coordinates as indicators of variation in red pine productivity among TWINSPAN classes: A case Study. Research Paper NC-310. North Central Forest Experiment Station, U.S. Department of agriculture, St. Paul, MN.



Ecological System								Fire-de	pendent	Forest							
Floristic Region			Northern			No	orthweste	ern			Central		Southern				
NPC Class	FDn12	FDn22	FDn32	FDn33	FDn43	FDw24	FDw34	FDw44	FDc12	FDc23	FDc24	FDc25	FDc34	FDs27	FDs36	FDs37	FDs38
Quaking aspen	3w	-	4wd	4d	3wd	2	1 d	1d		4	2 d	3	3d	10 d	2 d	6d	10 d
Jack pine	1	2	1 d	5d	10 d	3	4 d		1	1	1 d	2	9d	9d			
Red pine	2 d	1 d	3d	1 d	4 d				2 d	6 d	3d	6 d	1 d				
White pine	-	3	5wd	3d	2wd								2 d	2 d			
White spruce	4		-	10	7		3	3									
Northern pin oak												1wd		1wd		1wd	2wd
Black cherry														12wd		10wd	5wd
Red cedar														14wd			
Black oak														3wd			7wd
Shagbark hickory																	3wd
Basswood													10wd	18wd	3wd		17d
Paper birch	-	4	6wd	2d	1wd					5	5d	4	5d	6d	7d	8d	16d
Sugar maple			- Chu	24	2.00						54		<u> </u>	00	74	- Ou	19d
Northern red oak		7w		11wd						2w	6wd	8w	4wd	4wd	4wd	3wd	6d
Red maple		6w	-	8wd	8wd							9w	6wd			5d	
Bur oak						1w	2wd	4wd		3w	4wd	7w	7wd	7wd	1wd	2wd	1d
Ironwood														8wd			12d
Big-toothed aspen		5wd		7wd						7wd		5wd	8wd	-		7d	15d
White oak														5wd		4wd	8wd
Bitternut hickory														16w			11w
Butternut			ĺ			ĺ					ĺ						-
White ash														15wd			
Silver maple																	
American elm								6w						13w	5w	11w	4w
Green ash								5w				-		1011	6w	9w	
Box elder														19w		12w	13w
Red elm														-	-		18w
Hackberry																	14w
Cottonwood														17w			
Black walnut														11w			9w
Swamp white oak																	
River birch																	
Rock elm																	
					-												
White cedar	-		7	6	5 6											ļ	├
Balsam fir	5		7	6	6		F	2									├
Balsam popular						-	5	2								ļ	├
Black ash Yellow birch																	├
Tamarack																	
Black spruce	-		2	9	9												

Ecological System	Mesic Hardwood																
Floristic Region			Northern			NW			Central			Southern					
NPC Class	MHn35	MHn44	MHn45	MHn46	MHn47	MHw36	MHc26	MHc36	MHc37	MHc38	MHc47	MHs37	MHs38	MHs39	MHs49		
Quaking aspen	5d	1 d	9d	3d	11d	3d	2 d	5d	3d		8d		16d				
Jack pine																	
Red pine		15d					10 d										
White pine	9d	8 d	10 d				9d			2 d		10 d	8 d				
White spruce	-	6	6	14													
Northern pin oak												3wd					
Black cherry												13wd	19wd	-	16wd		
Red cedar																	
Black oak																	
Shagbark hickory												12wd					
Basswood	2wd	5wd	5wd	2wd	2wd	1wd	5wd	3wd	2wd	8wd	1wd	4d	3d	2d	1d		
Paper birch	4 d	4 d	3d	7d	4 d	-	3d	8 d	5d	5d	9 d	11 d	11d				
Sugar maple	1wd	13wd	1wd	6wd	1wd		6wd	1wd	1wd	1wd	4wd	7d	2 d	1d	2 d		
Northern red oak	3wd	11 wd		9wd	5wd		1wd	2wd	4wd	3wd	5wd	1 d	1 d	3d	14d		
Red maple	6wd	3wd	8wd	5wd	9 d		4 d	7 d			6d						
Bur oak	10wd	12wd		4wd		2wd	7wd	4wd	6wd	-	3wd	6 d	4 d	10 d	4d		
Ironwood	8wd				7wd		13wd	14wd	7wd	7wd		9d	5d	6d	12 d		
Big-toothed aspen	7wd			15wd			8 d	9d		-		14d	15d	12d			
White oak							11 wd	11 wd		9wd		2wd	7wd	11wd			
Bitternut hickory								10 w		11w		16w	10 w	7 w	10w		
Butternut								-			11 w	-		14w	13w		
White ash								12wd					14wd				
Silver maple															-		
American elm		-		16w		4w		-	8w		10w	5w	9w	5w	5w		
Green ash	Î	14w		8w	10w	5w	12w	6w	9w	10w	7w	-	6w	9w	11w		
Box elder												-	13w	13w	8w		
Red elm								-				8w	17w	4w	6w		
Hackberry												15w	12w	-	7w		
Cottonwood						-									-		
Black walnut												-			15w		
Swamp white oak																	
River birch																	
Rock elm															9w		
White cedar		7	4	11	8												
Balsam fir	12	2	7	12	-					6							
Balsam poplar		10		10		6											
Black ash		9w	-	1w	6			13		12	2	17	18	8	3		
Yellow birch	11 w		2w	13w	3					4							
Tamarack																	
Black spruce																	