

MUC System Protocol



Purpose

To classify land cover using the Modified UNESCO Classification (MUC) System

Overview

Students will learn how to use this hierarchical classification system to assign a MUC class to their land cover sample sites.

Time

15 to 45 minutes to make field observations and determine proper MUC class (excluding travel time to and from the site)

Level

All

Frequency

For land cover samples sites: Determine MUC class once during peak foliage

Key Concepts

- Canopy cover
- Ground cover
- Hierarchical land cover classification system

Skills

- Using a compass
- Measuring distances with paces
- Using classification systems
- Deciding based on definitions and rules
- Identifying tree and ground cover types
- Using the MUC system to identify the land cover class of a land cover sample site

Materials and Tools

- MUC system and definitions
- Compass
- Tubular densiometer
- Biometry Data Work Sheet

Preparation

Review the MUC system and the classification examples.

Identify MUC classes that are applicable to your local area.

Prerequisites

Leaf Classification Learning Activity

Learn to pace.

Learn to use the compass and densiometer.

Introduction

In GLOBE, we use the Modified UNESCO Classification (MUC) System for classifying land cover. MUC has an ecological basis and follows international standards. The MUC system has four levels of classification arranged hierarchically. As you can see in Tables LAND-P-3 and LAND-P-4 each higher level is based on more detailed properties of land cover. MUC codes of up to four digits are associated with each MUC class with one digit for each level in the class beginning with the lowest level. In assigning a MUC class to a homogeneous area of land cover, always begin at the lowest level (i.e. the first digit of the MUC code) and proceed up the levels one-by-one. The

definitions of the MUC classes are given in the *Appendix*, and students should always refer to these definitions rather than trusting their memories or general knowledge when determining the MUC class for an area.

A classification system is a comprehensive set of categories, with labels and definitions, typically arranged in a hierarchy or branching structure. A classification system is used to organize a set of data, such as an inventory of land cover types, into meaningful groups. The classification system must be both *totally exhaustive* and *mutually exclusive*. A *totally exhaustive* classification has an appropriate class for every possible data point (e.g., land cover type). A *mutually exclusive*

Table LAND-P-3: MUC Level 1 and 2

	Level 1	Level 2	
Natural Cover	0 Closed Forest	01 Mainly Evergreen Forest 02 Mainly Deciduous Forest 03 Extremely Xeromorphic (Dry) Forest	
	1 Woodland	11 Mainly Evergreen Woodland 12 Mainly Deciduous Woodland 13 Extremely Xeromorphic (Dry) Woodland	
	2 Shrubland	21 Mainly Evergreen Shrubland 22 Mainly Deciduous Shrubland 23 Extremely Xeromorphic (Dry) Shrubland	
	3 Dwarf-shrubland	31 Mainly Evergreen Dwarf-shrubland 32 Mainly Deciduous Dwarf-shrubland 33 Extremely Xeromorphic Dwarf-shrubland 34 Tundra	
	4 Herbaceous Vegetation	41 Tall Graminoid 42 Medium Tall 43 Short Graminoid 44 Forb (broad-leaved) Vegetation	
	5 Barren Land	51 Dry Salt Flats 52 Sandy Areas 53 Bare Rock 54 Perennial Snowfields 55 Glaciers 56 Other	
	6 Wetland	61 Riverine 62 Palustrine 63 Estaurine 64 Lacustrine	
	7 Open Water	71 Freshwater 72 Marine	
	Developed Cover	8 Cultivated Land	81 Agriculture 82 Non-agriculture
		9 Urban	91 Residential 92 Commercial/Industrial 93 Transportation 94 Other

Sources: UNESCO, 1973 and GLOBE, 1996

classification has one and only one appropriate class for every data point. The hierarchical arrangement means that there are multiple levels of classes: level 1 has the most general classes; each higher level in the system increases in detail and multiple detailed classes may be condensed into fewer more general classes. For example:

The MUC System has ten level 1 classes, including *Closed Forest*, *Woodland*, and *Urban*. See Tables LAND-P-3 and LAND-P-4. The level 2 classes within *Closed Forest* are *Mainly Evergreen Forest*, *Mainly Deciduous Forest*, and *Extremely Xeromorphic (dry) Forest*. These level 2 classes contain more detail than the level 1 class, *Closed Forest*, and they may all be collapsed into the *Closed Forest* class. In other words, any member of one of these three Level 2 classes is always a member of the *Closed Forest* level 1 class. Table LAND-P-3 is a condensed version of MUC, showing only the level 1 and level 2 classes.

The entire MUC classification system is outlined in Table LAND-P-4. Be aware that this outline contains only the name and identifying code number of each class. The full definition and description of each class is detailed in the Glossary

of Terms for the Modified UNESCO Classification System. The Glossary is found in the *Appendix*. Each class is strictly defined by clear decision criteria.

An Example of Determining MUC Class to Level 2

Figure LAND-P-17 illustrates the criteria used to distinguish between Forest and Woodland classes at MUC level 1 criteria used to distinguish between Mainly Deciduous, Mainly Evergreen, and Mainly Xeromorphic cover types at level 2.

More than 40% of the land cover sample must be covered by trees to qualify as forest or woodland. If the tree crowns are interlocking (branches from neighboring trees touch each other) the sample site is considered forest. If the trees are spread farther apart and branches do not touch each other, the sample site is considered woodland. The level 2 classes typically depend on the composition of the level 1 cover type. In this example, the level 2 class for Forest or Woodland depends upon the percentage of deciduous and evergreen trees in the canopy.

Figure LAND-P-17: Applying MUC to Forest and Woodland

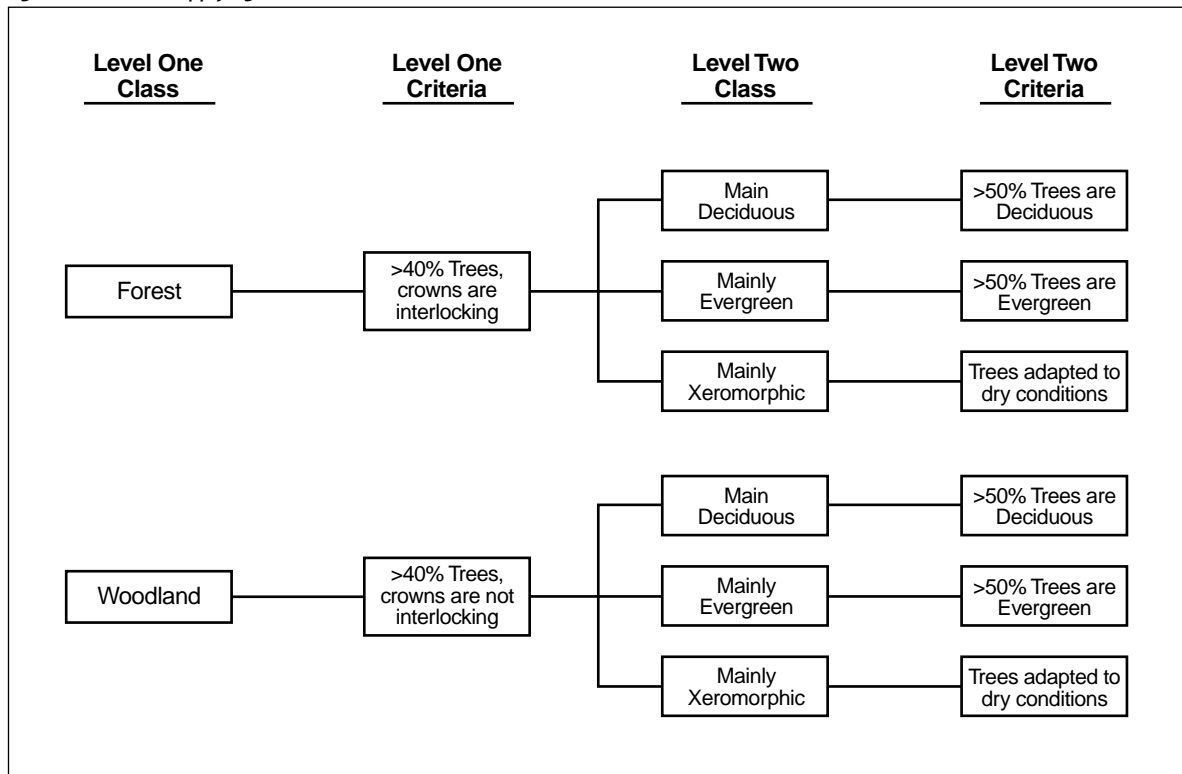


Table LAND-P-4: MUC Level 1 - 4

LEVEL 1	LEVEL 2	LEVEL 3	LEVEL 4	NOTES AND EXAMPLES
Natural Cover	01 Mainly Evergreen Forest	011 Tropical Wet (Rain) Forest	0111 Lowland forest	Costa Rica: Atlantic slope Costa Rica: Sierra de Talamanca Jamaica: Blue Mountains
			0112 Submontane forest	
			0113 Montane forest	
			0114 "Subalpine" forest	
			0115 Cloud forest	
		012 Tropical and Subtropical Evergreen Seasonal	0121 Lowland forest	
			0122 Submontane forest	
			0123 Montane forest	
			0124 "Subalpine" forest	
		013 Tropical and Subtropical Semi-deciduous	0131 Lowland forest	<i>Ceiba spp.</i>
			0133 Montane or cloud forest	
		014 Subtropical Wet Forest	0141 Lowland forest	Queensland, Australia, and Taiwan
			0142 Submontane forest	
			0143 Montane forest	
			0144 "Subalpine" forest	
			0145 Cloud forest	
		015 Temperate and Subpolar Evergreen Wet Forest	0151 Temperate evergreen wet forest	Chilean Coast
			0152 Subpolar evergreen wet forest	
		016 Temperate Evergreen with Deciduous Broad-leaved	0161 Lowland forest	<i>Eucalyptus regnans, E. diversicolor</i> USA: California live-oak forest
0162 Submontane forest				
0163 Montane forest				
0164 "Subalpine" forest				
017 Winter-Rain Evergreen Broad-leaved Sclerophyllous	0171 Lowland and submontane	<i>Pinus spp. forest of Honduras and Nicaragua</i> <i>Pinus spp. forest of Philippines and southern Mexico</i>		
	0172 Lowland and subm. <50m tall			
018 Tropical and Subtropical Evergreen Needle-leaved	0181 Lowland and submontane	<i>Sequoia and Pseudotsugaspp., Pacific W. of N. America</i> <i>Pinus spp.</i> <i>Picea and Abies spp.: USA California Red Fir forests</i> Boreal, short branches		
	0182 Montane and subalpine			
019 Temperate and Subpolar Evergreen Needle-leaved	0191 Giant forest (>50 m)			
	0192 (Irregularly) Rounded crowns			
	0193 Conical crowns			
	0194 Cylindrical crowns			

Table LAND-P-4: MUC Level 1-4 (continued)

LEVEL 1	LEVEL 2	LEVEL 3	LEVEL 4	NOTES AND EXAMPLES	
0 Closed Forest	02 Mainly Deciduous Forest	021 Tropical and Subtropical Drought-deciduous	0211 Broad-leaved lowland and submontane 0212 Montane and cloud forest	Northwest Costa Rica Northern Peru	
		022 Cold-deciduous Forest with Evergreen Trees and Shrubs	0221 With evergreen broad-leaved trees and climbers 0222 With evergreen needle-leaved trees	Western Europe: <i>Ilex aquifolium</i> , <i>Hedera helix</i> North America: <i>Magnolia</i> spp. Northeastern US: maple-hemlock forest	
		023 Cold-deciduous Forest without Evergreen Trees	0231 Temperate lowland and submontane broad-leaved 0232 Montane or boreal 0233 Subalpine or subpolar	Grades into woodland	
		031 Sclerophyllous-dominated			
	03 Extremely Xeromorphic (Dry) Forest	032 Thorn-forest	0321 Mixed deciduous-evergreen 0322 Purely deciduous		
		033 Mainly Succulent Forest			
		111 Evergreen Broad-leaved			
	1 Mainly Deciduous	112 Evergreen Needle-leaved	1121 Rounded crowns 1122 Conical crowns prevailing 1123 Narrow cylindrical crowns		<i>Pinus</i> spp. Mostly subalpine Boreal regions: <i>Picea</i> spp.
			121 Drought-deciduous	1211 Broad-leaved lowland and submontane 1212 Montane and cloud forest	
			122 Cold-deciduous with Evergreens	1221 With evergreen broad-leaved trees and climbers 1222 With evergreen needle-leaved trees	
123 Cold-deciduous without Evergreens			1231 Broad-leaved deciduous 1232 Needle-leaved deciduous 1233 Mixed deciduous		
13 Extremely Xeromorphic (Dry)		131 Sclerophyllous-dominated			
		132 Thorn-forest	1321 Mixed deciduous-evergreen 1322 Purely deciduous		
		133 Mainly Succulent Forest			
1 Woodland					

Table LAND-P-4: MUC Level 1 -4 (continued)

LEVEL 1	LEVEL 2	LEVEL 3	LEVEL 4	NOTES AND EXAMPLES	
Natural Cover	21 Mainly Evergreen	211 Evergreen Broad-leaved	2111 Low bamboo thicket	Mediterranean dwarf-palm, Hawaiian tree-fern Subalpine Rhododendron thickets, or Hibiscus tillaeceus matted thickets of Hawaii, USA Chapparal or macchia <i>Cistusheath</i>	
			2112 Evergreen tuft-tree		
			2113 Broad-leaved hemiscleophyllous		
			2114 Broad-leaved sclerophyllous		
			2115 Suffruticose thicket		
		212 Evergreen Needle-leaved and Microphyllous	2121 Evergreen needle-leaved	<i>Pinus mughus</i> , "Krummholz" Tropical subalpine	
	2122 Evergreen microphyllous				
	22 Mainly Deciduous	221 Drought-deciduous Mixed with Evergreen Woody Plants	2231 Temperate deciduous	Australia, N. America: Atriplex-Kochia-saltbush	
			2232 Subalpine or subpolar		
		222 Drought-deciduous without Evergreens	2311 Mainly Evergreen	2312 Semi-deciduous subdesert	E. Mediterranean: Astragalus and Acantholimon spp.
			2321 Without succulents	2322 With succulents	
	31 Mainly Evergreen	311 Evergreen Dwarf-shrub Thicket	3111 Caespitose thicket	<i>Calluna heath</i>	
3112 Creeping or matted thicket			<i>Loiseleuria heath</i>		
312 Evergreen Dwarf-shrubland			E. Mediterranean: Astragalus and Acantholimon spp.		
313 Mixed Evergreen and Herbaceous Formation		3131 True evergreen & herbaceous mixed	<i>Nardus-Calluna heath</i>	Greece: Phryganasp.	
		3132 Partial evergreen & herbaceous mixed			
		321 Facultative Drought-deciduous			
3 Dwarf-Shrubland	322 Obligate Drought-deciduous	3221 Drought-deciduous caespitose	Drought-deciduous cushion creeping or matted Drought-deciduous mixed		
		3222 Drought-deciduous			
		3223 Drought-deciduous cushion			
		3224 Drought-deciduous mixed			
	323 Cold-deciduous	3231 Drought-deciduous caespitose	Drought-deciduous cushion creeping or matted Drought-deciduous mixed		
		3232 Drought-deciduous			
3233 Drought-deciduous cushion	3233 Drought-deciduous cushion	Drought-deciduous cushion creeping or matted Drought-deciduous mixed			
	3234 Drought-deciduous mixed				

Table LAND-P-4: MUC Level 1-4 (continued)

LEVEL 1	LEVEL 2	LEVEL 3	LEVEL 4	NOTES AND EXAMPLES	
Natural Cover	3 Dwarf-Shrubland	331 Extremely Xeromorphic	3311 Mainly Evergreen	3311 Evergreen subdesert	
			3312 Deciduous Subdesert	3312 Semi-deciduous subdesert	
		34 Tundra	3321 Without succulents	3321 Without succulents	
			3322 With succulents	3322 With succulents	
	4 Herbaceous Vegetation	41 Tall Graminoid	341 Mainly Bryophyte	3411 Caespitose	
			342 Mainly Lichen	3412 Creeping or matted	
		42 Medium Tall	411 With Trees Covering 10-40 %	4110 Trees: needle-leaved evergreen	4110 Trees: needle-leaved evergreen
				4111 Trees: broad-leaved evergreen	4111 Trees: broad-leaved evergreen
			412 With Trees < 10 %	4112 Trees: broad-leaved semi-evergreen	4112 Trees: broad-leaved semi-evergreen
				4113 Trees: broad-leaved deciduous	4113 Trees: broad-leaved deciduous
413 With Shrubs	4120 Trees: needle-leaved evergreen	4120 Trees: needle-leaved evergreen			
	4121 Trees: broad-leaved evergreen	4121 Trees: broad-leaved evergreen			
	414 With Tuft Plants (usu. palms)	4122 Trees: broad-leaved semi-evergreen	4122 Trees: broad-leaved semi-evergreen		
		4123 Trees: broad-leaved deciduous	4123 Trees: broad-leaved deciduous		
	415 Without Woody Synusia	4124 Tropical or subtropical with trees and shrubs in tufts on termite nests	4124 Tropical or subtropical with trees and shrubs in tufts on termite nests		
		4130 Shrubs: needle-leaved evergreen	4130 Shrubs: needle-leaved evergreen		
	421 With Trees Covering 10-40 %	4131 broad-leaved evergreen	4131 broad-leaved evergreen		
		4132 Shrubs: broad-leaved semi-evergreen	4132 Shrubs: broad-leaved semi-evergreen		
	422 With Trees < 10 %	4133 Shrubs: broad-leaved deciduous	4133 Shrubs: broad-leaved deciduous		
		4134 Tropical or subtropical with trees & shrubs in tufts on termite nests	4134 Tropical or subtropical with trees & shrubs in tufts on termite nests		
		4141 Tropical with palms	4141 Tropical with palms		
		4151 Tropical	4151 Tropical		
	4210 Trees: needle-leaved evergreen	4210 Trees: needle-leaved evergreen	4210 Trees: needle-leaved evergreen		
		4211 broad-leaved evergreen	4211 broad-leaved evergreen		
	4212 Trees: broad-leaved semi-evergreen	4212 Trees: broad-leaved semi-evergreen	4212 Trees: broad-leaved semi-evergreen		
		4213 Trees: broad-leaved deciduous	4213 Trees: broad-leaved deciduous		
	4220 Trees: needle-leaved evergreen	4220 Trees: needle-leaved evergreen	4220 Trees: needle-leaved evergreen		
		4221 broad-leaved evergreen	4221 broad-leaved evergreen		
		4222 Trees: broad-leaved semi-evergreen	4222 Trees: broad-leaved semi-evergreen		
		4223 Trees: broad-leaved deciduous	4223 Trees: broad-leaved deciduous		
	4224 Tropical or subtropical with trees & shrubs in tufts on termite nests	4224 Tropical or subtropical with trees & shrubs in tufts on termite nests	4224 Tropical or subtropical with trees & shrubs in tufts on termite nests		

Table LAND-P-4: MUC Level 1-4 (continued)

LEVEL 1	LEVEL 2	LEVEL 3	LEVEL 4	NOTES AND EXAMPLES
4 Herbaceous Vegetation	42 Medium Tall	423 With Shrubs	4230	Shrubs: needle-leaved evergreen
			4231	broad-leaved evergreen
			4232	Shrubs: broad-leaved semi-evergreen
			4233	Shrubs: broad-leaved deciduous
			4234	Tropical or subtropical with trees & shrubs in tufts on termite nests
			4235	Woody synusia of deciduous thorny shrubs
			4241	Subtropical with open palm groves
			4251	Mainly sod grasses
			4252	Mainly bunch grasses
			425	Open Synusia of Tuft Plants
43 Short Graminoid	431 With Trees Covering 10-40 %	4310	Trees: needle-leaved evergreen	
			4311	broad-leaved evergreen
			4312	Trees: broad-leaved semi-evergreen
			4313	Trees: broad-leaved deciduous
			4320	Trees: needle-leaved evergreen
			4321	broad-leaved evergreen
			4322	Trees: broad-leaved semi-evergreen
			4323	Trees: broad-leaved deciduous
			4324	Tropical or subtropical with trees & shrubs in tufts on termite nests
			432	With Trees < 10 %
433 With Shrubs	4330	Shrubs: needle-leaved evergreen		
		4331	broad-leaved evergreen	
		4332	Shrubs: broad-leaved semi-evergreen	
		4333	Shrubs: broad-leaved deciduous	
		4334	Tropical or subtropical with trees & shrubs in tufts on termite nests	
		4335	Woody synusia of deciduous thorny shrubs	
		4341	Subtropical with open palm groves	
		4351	Tropical alpine with tuft plants	
		4352	Tropical alpine, but very open, with no tuft plants	
		4353	Tropical or subtropical with open stands of evergreens	
4354	With dwarf-shrubs			
436	Without Woody Synusia			
437 Short to Medium Tall Mesophytic Communities	4361	Short-grass communities		
		4362	Bunch-grass communities	
		4371	Sodgrass communities	
4372	Alpine, subalpine meadows			

Table LAND-P-4: MUC Level 1 -4 (continued)

	LEVEL 1	LEVEL 2	LEVEL 3	LEVEL 4	NOTES AND EXAMPLES	
Natural Cover	4 Herbaceous Vegetation	44 Forb Vegetation	441 Tall Forb Communities	4411 Fern thickets 4412 Mainly annual forbs		
			442 Low Forb Communities	4421 Mainly perennial flowering forbs and ferns 4422 Mainly annual forbs		
	5 Barren Land	51 Dry Salt Flats 52 Sandy Areas 53 Bare Rock 54 Perennial Snowfields 55 Glaciers 56 Other				
			6 Wetland	61 Riverine		
				62 Palustrine		
				63 Estuarine		
				64 Lacustrine		
			7 Open Water	71 Freshwater		
	72 Marine					
	Developed Cover	8 Cultivated Land	81 Agriculture	811 Row Crop or Pasture		
				812 Orchard or Horticulture		
				813 Confined Livestock feeding		
814 Other Agriculture						
82 Non-agriculture		821 Parks and Athletic fields				
		822 Golf Courses				
		823 Cemeteries				
		824 Other Non-agriculture				
9 Urban		91 Residential 92 Commercial/Industrial 93 Transportation 94 Other				

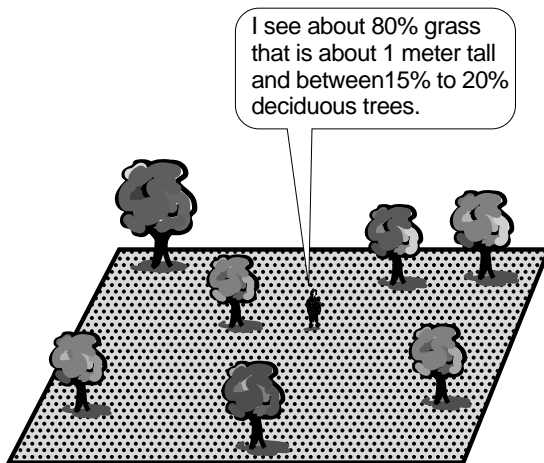
Sources: UNESCO, 1973 and GLOBE, 1996

Additional Examples of How to Use the MUC System

The following examples demonstrate the classification process. Refer to the MUC outline (Table LAND-P-4), and to the MUC Glossary in the *Appendix* as you read them.

Example 1

For your Land Cover Sample Site (90 m x 90 m) you pick a relatively homogeneous area of grasses. About 80% of the site is covered by grass and herbaceous plants about 1 meter tall (a 75/25 mix, respectively), and about 15-20% by broad-leaved deciduous trees.



Level 1: You see on the MUC Classification that class 4, Herbaceous Vegetation is probably the appropriate level 1 class. In the MUC Glossary, you see that class 4 requires greater than 60% total ground coverage of herbaceous vegetation over the entire study site, confirming that class 4 is appropriate.

Level 2: On the *MUC Classification*, you now see four choices at level 2 (41-44). After reviewing the definitions of these four classes in the MUC Glossary, you determine that, since the dominant cover type (herbaceous) is more than 50% grass, the level 2 cover type must be Graminoid. Since the grass is between 50 cm and 2 m tall, you select class 42, Medium Tall Graminoid.

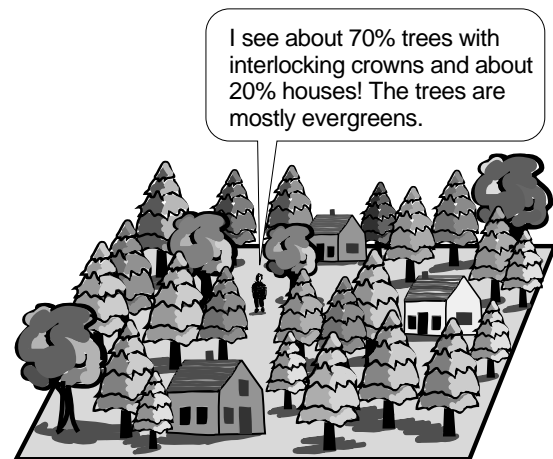
Level 3: On the *MUC Classification*, you now have five Level 3 choices (421-425). Since trees cover 15-20% of the study site, you select Class 421,

"With trees covering 10-40%", confirming this selection with the MUC Glossary definition.

Level 4: You now have three choices at Level 4 (4211-4213). Since the trees are broad-leaved deciduous, you select class 4213, and you have completed your MUC level 4 classification.

Example 2

You live in a lowland temperate region. You select a Land Cover Sample Site that is mostly forested with the tree crowns touching each other, but about 20% of the ground area has houses on it. Of the trees, it looks like there are more evergreen than deciduous trees, probably a 60/40 split.



Level 1: On the *MUC Classification* you check your Level 1 choices and find that, since the tree crowns are interlocking, and there is more than 40% canopy cover over the entire study site, Closed Forest, class 0, is the level 1 class.

Level 2: You now have three level 2 choices (01-03). Since at least 50% of the trees that reach the canopy are evergreen, you select class 01, Mainly Evergreen at level 2.

Level 3: You now have nine level 3 choices (011-019), but five are explicitly tropical and subtropical. A sixth choice is a winter-rain category which is also clearly not appropriate. So you have only three categories to seriously consider (015, 016, 019), and after consulting the MUC Glossary you select 016, Temperate Evergreen with Deciduous Broad-leaved.

Level 4: Now you have four level 4 choices (0161-0164). Since you live in a lowland area, class 0161, Lowland forest is the appropriate selection.

How to Classify Land Cover Using the MUC System

When classifying land cover using the MUC system, always begin with the most general classes (level 1) and proceed sequentially to the more detailed (higher level) classes. There are ten level 1 land cover classes in MUC. Eight of these choices are natural land cover and two are developed. At no other level in the MUC system are there more than six land cover choices, and therefore, the level 1 choice among ten classes is the most challenging decision to make. However, given that these ten classes are the most general, the distinctions among them are broad and the decision as to which level 1 land cover class to pick is usually not difficult. Always refer to the definitions for each land cover class to help you in choosing the appropriate class at every level.

How to Classify Land Cover to MUC Level 1

Step 1: Eliminate as many MUC level 1 classes as possible.

- Compare the Land Cover Sample Site with the definitions of the 10 MUC level 1 classes.
- Usually there are only a few level 1 classes that can possibly match your site; eliminate the others from consideration.

Step 2: Make any measurements necessary to determine the MUC level 1 class.

- Perform measurements of tree height, canopy cover, or ground cover and identify dominant and co-dominant species as necessary to distinguish between different MUC level 1 classes. Follow the appropriate portions of the Biometry Protocol. In many cases no measurements will be necessary.
- Using the quantitative measurements, resolve any questions and assign a MUC level 1 class to this site.

Step 3: Check your assignment.

Read the definitions for the MUC levels 2, 3, and 4 for your chosen MUC level 1 class that are possible for your area. If none of the definitions

of higher level MUC classes match your site, reconsider your choice of MUC level 1 class in Step 2.

How to Classify Land Cover Sample to MUC levels 2, 3, and 4

Step 1: Determine the MUC level 2 class.

- Review the level 2 definitions that apply to the MUC level 1 class of your site.
- Select the MUC level 2 class that applies to your site.
- If necessary, make measurements of the vegetation on your site to resolve quantitative distinctions between different level 2 classes using the procedures given in *Using Field Observations to Determine MUC Class*.

Step 2: Determine the MUC level 3 class.

- Review the level 3 definitions that apply to the MUC level 2 class of your site. If there are none, record your MUC level 2 class (two digits); you have completed this protocol.
- Select the MUC level 3 class that applies to your site.
- If necessary, make additional measurements of the vegetation on your site to resolve quantitative distinctions between different level 3 classes using the procedures given in *Using Field Observations to Determine MUC Class*.

Step 3: Determine the MUC level 4 class.

- Review the level 4 definitions that apply to the MUC level 3 class of your site. If there are none, record your MUC level 3 class (three digits); you have completed this protocol.
- Select the MUC level 4 class that applies to your site.
- If necessary, make additional measurements of the vegetation on your site to resolve quantitative distinctions between different level 4 classes using the procedures given in *Using Field Observations to Determine MUC Class*.
- Record your MUC level 4 class.



Using Field Observations to Determine MUC Class

Distinguishing among some MUC classes requires quantitative measurements of the percentage of your site that is covered by different types of vegetation. This can be accomplished using modified versions of the Canopy and Ground Cover measurement procedures of the *Biometry Protocol*. You can identify the appropriate MUC class by calculating the percentages of the vegetation types observed at the Land Cover Sample Site. Use the *Dominant/Co-Dominant Vegetation Data Work Sheet* to add up your canopy and/or ground cover observations. You can calculate percentages of deciduous and evergreen canopy cover, and graminoid and forb ground cover in addition to the total canopy cover and green, brown, and total ground cover measurements presented in the *Biometry Protocol*.



Determining the Percentage of Tree Cover That is Evergreen or Deciduous

Step 1: Make a modified canopy cover measurement.

- Repeat the canopy cover measurement from the *Biometry Protocol* but at each location note “E” if the canopy touching the crosshairs is part of an evergreen tree and “D” if the canopy touching the crosshairs is part of a deciduous tree.

Step 2: Calculate the percentage of the canopy that is evergreen or deciduous.

- Divide the number of E observations (or D observations) by the sum of the E’s and the

D’s and multiply by 100. If the percentage of evergreen species is greater than 50%, then the site is considered mainly evergreen.

Determining the Composition of Herbaceous Coverage:

Step 1: Make a modified measurement of ground cover.

- Repeat the ground cover measurement from the *Biometry Protocol*, but instead of noting whether vegetation is green or brown, note whether it is graminoid (grass) or forb (broad leafed) and record a “GD” if the vegetation under foot or touching the ankle or leg below the knee is a graminoid and an “FB” if it is a forb.

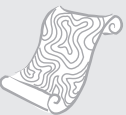
Step 2: Calculate the percentage of ground cover that is graminoid or forb.

- Divide the number of GD measurements (or FB measurements) by the sum of the GD’s and FB’s and multiply by 100 to obtain a percentage. If the percentage of graminoid species is greater than 50%, then the sample is considered graminoid. Conversely, if the percentage of forb is greater than 50%, then the sample is considered forb.



$$\% \text{ Evergreen} = \frac{\# \text{ of E's (evergreen observations)}}{\# \text{ of E's} + \# \text{ of D's (total canopy cover observations)}} \times 100$$

$$\% \text{ Graminoid} = \frac{\# \text{ of GD's (Graminoid Observations)}}{\# \text{ of GD's} + \# \text{ of FB's (Total \# of Herbaceous Ground Observations)}} \times 100$$



Determining Total Shrub Canopy Cover

If your site or area is one where the dominant land cover types is naturally occurring shrubland or dwarf shrubland (ornamental and cultivated shrubs do not count), you should slightly modify one of the preceding procedures. The equations for canopy cover percentage can be adapted to determine the total shrub canopy cover as well as the percentage of evergreen and deciduous shrubs.

Step 1: Determining the Amount of Shrub Cover

- If the canopy of the shrub cover is over head, carry out the canopy cover measurement from the Biometry Protocol. If the canopy cover touching the crosshairs is shrub record “SB”, if it is a deciduous tree record “D”, and if it is an evergreen tree record “E”. If the shrubs are too short to make true canopy observations (i.e. they are too short to walk under), treat the shrubs as an additional ground cover category along with graminoid and forb. Carry out the ground cover measurement from the Biometry Protocol, recording “GD” if the vegetation touching the observer’s body at any height is a graminoid, “FB” if the vegetation is a forb, and “SB” if it is a shrub.

Step 2: Calculate the Percentage of Shrub Cover

- If the shrub cover is over head, divide the number of SB measurements by the sum of the SB, D, and E measurements. If the shrubs are not overhead, divide the number of SB measurements by the sum of the SB, GD, and FB measurements. Multiply by 100 to obtain a percentage.

References

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$$\% \text{ Shrub} = \frac{\# \text{ of SB's (Shrub Observations)}}{\# \text{ of SB's} + \# \text{ of E's} + \# \text{ of O's (Total canopy cover observations)}} \times 100$$

OR

$$\% \text{ Shrub} = \frac{\# \text{ of SB's (Shrub Observations)}}{\# \text{ of SB's} + \# \text{ of GD's} + \# \text{ of FB's (Total ground cover observations)}} \times 100$$