

Ecological Similarity Classes and Criteria for Assigning Fuzzy Set Values

Fuzzy set validation assessment is being used to evaluate land cover mapping by comparing the label of reference point to map. The validation is intended to assess ecological similarity, rather than spectral similarity (i.e. morphologically), between Ecological System cover types confused by the map model.

Note: This validation is designed to test the accuracy of the mapping process (i.e. the map models) not the accuracy of the map itself.

This process is to be done on individual mega mapping zones. It is not intended to be performed on entire state responsibility areas. For optimum results and consistent scoring, rely on your working knowledge of each mega mapping zone and reference the NVCS legend descriptions often.

I. Table Set Up Directions:

- Start with the original error matrix created from your 80% data set using the 20% withheld validation data set for each mapping zone. (Table 3).
- Copy the error matrix into an empty spreadsheet. Identify areas of confusion between the reference and mapped classes by highlighting those individual cells. Clear the contents of the data cells leaving just the land cover class information in the corresponding row and column headings along with any highlighted cells. Make a second copy of this spreadsheet to prepare for the steps below.
- Follow the **Ecological Similarity Directions** below to populate Tables 4 and 5. Please complete Tables 4 and 5 and return to USU for each mega mapping zone within your responsibility area.

II. Ecological Similarity Directions:

- **When Map and Reference DO Match:** By definition, the map and reference will be identical along the diagonal, therefore all *Major Types of Ecological Similarity* would apply. Using the spreadsheet with the highlighted cells, enter 'ABCD' into the cells along the diagonal.
- **When Map and Reference DO NOT Match:** (Note: *Italicized* text refers to concepts within Tables 1 and 2.)

- Step 1 Evaluate the Major Types of Ecological Similarity:** For the highlighted cells off the diagonal, determine which, if any, of the *Ecological Similarity Codes* listed in Table 1 describe(s) the level of similarity between the reference and mapped classes. Assign the corresponding *Ecological Similarity Code* (i.e. A-D). For reference and mapped classes without ecological similarity, leave blank. You have now populated Table 4.
- Step 2 Tally the Number of Major Types of Ecological Similarity:** Count the number of *Ecological Similarity Codes* that were entered in Table 4. (e.g. If *Ecological Similarity Code* is equal to 'ACD,' then the *Ecological Similarity Number* will tally to 3.)
Note: The number generated in this step is used to determine the *Index of Relative Similarity Score* as described in Table 2.
- Step 3 Apply the Index of Relative Similarity Score:** Important- Use the tally number of *Ecological Similarity Code* (from Step 2) to select the most appropriate *Relative Similarity Description* (Table 2). This description will correspond with an *Index of Relative Similarity Score*. Use the second copy of the highlighted spreadsheet to enter the *Relative Similarity Score* for each confused cell (e.g. If *Ecological Similarity Number* is equal to 3, then the *Relative Similarity Score* will be 4 VERY SIMILAR). You have now populated Table 5.
- Step 4 Identify where Reference and Mapped Classes are Incorrect:** Highlighted cells that were left blank in Table 4 should indicate confusion between a reference and mapped class that are not ecologically similar, therefore the *Ecological Similarity Number* is equal to 0, and the *Index of Relative Similarity Score* would be 1 INCORRECT.

Table 1: Major Types of Ecological Similarity

<i>Ecological Similarity Code*</i>	<i>Ecological Similarity Name</i>	<i>Ecological Similarity Description</i>
A	Physiognomic Structure (Map and reference have same NLCD class)	Where reference and mapped classes share the same NLCD Class, such as: <ul style="list-style-type: none"> – N30-Barren (Includes all Barren Lands) – N40-Forest (Includes all Deciduous Forest, Evergreen Forest and Mixed Forest types) – N50-Shrubland (Includes all Shrub, Dwarf Shrub and Shrub/Scrub types) – N70-Herbaceous (Includes all Grassland, Herbaceous, Savanna and Shrub-Steppe types) – N90-Wetlands (Includes all Wetland, Riparian, Emergent Wetlands, Wet Meadows and Greasewood Flats)
B	Dominant Species Composition	Where reference and mapped classes share dominant/diagnostic species as specified in concept of Ecological Systems. For example, if systems share <i>dominant</i> or <i>codominant</i> species, then species composition is similar. If systems share species that are only <i>present</i> , then species composition is not similar. Would also apply if the confusion occurs between systems where the dominant/codominant species is common, but has been identified to a different subspecies (i.e. <i>Artemisia tridentata</i> spp.).
C	Juxtaposition (Form mosaics/ Ecotonal)	Where reference and mapped classes commonly form a mosaic, such as where patch or linear systems occur within matrix systems, or where broad ecotonal boundaries between the classes occur with regularity. This often relates to minimum mapping unit (scale) issues with mosaics of similar landcover types. Refrain from using this code when the possibility of juxtaposition is only a rare occurrence.
D	Special Substrates	Where reference and mapped classes share substrates with special properties that ecologically define each Ecological System. To be applied with the following substrates only: <ul style="list-style-type: none"> – Eolian (Sandsheets and Dunes) – Bedrock (exposed weathering parent material); sparse vegetation (Barren) classes only – High Salinity (exposed marine shales, saline overflow /playas)

* These codes are to be applied on a mega mapping zone-by-mega mapping zone basis.

Table 2: Steps to Determine the Relative Similarity Score

<i>Ecological Similarity Code</i>	<i>Ecological Similarity Number</i>	<i>Relative Similarity Description</i>	<i>Relative Similarity Category</i>	<i>Example</i>	<i>Explanation</i>	<i>Relative Similarity Score</i>
Empty Cell	0	The reference and map do not correspond and they DO NOT SHARE ANY of the <i>Major Types of Ecological Similarity</i> .	INCORRECT	Intermountain Basins Mixed Salt Desert Scrub reference and Rocky Mountain Aspen Forest & Woodland mapped	No Major Types of Ecological Similarity are appropriate for this error. Relationship is incorrect.	1
A	1	The reference and map do not correspond but they DO SHARE the same NLCD class, are juxtaposed, OR have a special substrate in common.	SOMEWHAT SIMILAR	Rocky Mountain Gambel-Oak Mixed Montane Shrubland reference and Inter-Mountain Basins Mixed Salt Desert Scrub mapped	Both Ecological Systems are nested within the N50 NLCD Class and do not share any other <i>Major Types of Ecological Similarity</i> . Relationship is somewhat correct.	2
C						
D						
B	1	The reference and map do not correspond, but they DO SHARE dominant/codominant species OR have exactly 2 major types of <i>Major Types of Ecological Similarity</i> in common.	MODERATELY SIMILAR	Inter-Mountain Basins Mixed Salt Desert Scrub reference and Inter-mountain Basins Greasewood Flat mapped	These Ecological Systems share C- Juxtaposition and D- Special Substrates. Relationship is moderately similar.	3
AB	2					
AC	2					
AD	2					
BC	2					
BD	2					
CD	2					
ABC	3	The reference and map do not correspond, but they DO SHARE 3 or more major types of <i>Major Types of Ecological Similarity</i> .	VERY SIMILAR	Inter-Mountain West Aspen - Mixed Conifer Forest & Woodland reference and Rocky Mountain Aspen Forest & Woodland mapped	These Ecological Systems share A- Physiognomic Structure, B- Dominant Species Composition and C- Juxtaposition. Relationship is very similar.	4
ABD	3					
ACD	3					
BCD	3					
ABCD	4					
Correct Match Cell	5	The reference and map match.	CORRECT	Mogollon Chaparral reference and Mogollon Chaparral mapped	The reference and mapped classes are identical. Relationship is correct.	5

Table 3. Original Error Matrix Using 20% Validation Data (UT-5)

ECOLOGICAL SYSTEM	CLASS	S009	S023	S028	S040	S050	S054	S055	S065	S071	S078	S090	S096	S118	TOT	%ACC
Inter-Mountain Basins Cliff and Canyon	S009	5	0	0	0	0	0	1	0	0	0	0	0	0	6	83%
Rocky Mountain Aspen Forest and Woodland	S023	0	4	0	0	0	0	0	0	0	0	0	0	0	4	100%
Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland	S028	0	0	5	0	0	0	0	0	0	0	0	0	0	5	100%
Great Basin Pinyon-Juniper Woodland	S040	0	0	0	17	0	0	0	0	0	0	1	0	0	18	94%
Inter-Mountain Basins Mountain Mahogany Woodland and Shrubland	S050	0	0	0	0	1	0	0	0	0	0	0	0	0	1	100%
Inter-Mountain Basins Big Sagebrush Shrubland	S054	0	0	0	1	0	54	12	2	2	6	3	1	0	81	67%
Great Basin Xeric Mixed Sagebrush Shrubland	S055	0	0	0	0	0	2	8	1	2	1	0	0	0	14	57%
Inter-Mountain Basins Mixed Salt Desert Scrub	S065	0	0	0	0	0	0	1	2	0	0	0	0	0	3	67%
Inter-Mountain Basins Montane Sagebrush Steppe	S071	1	2	0	0	1	1	3	0	18	2	1	1	0	30	60%
Inter-Mountain Basins Big Sagebrush Steppe	S078	0	0	0	0	0	1	0	0	0	0	0	1	0	2	0%
Inter-Mountain Basins Semi-Desert Grassland	S090	0	0	0	0	0	1	0	0	0	0	3	0	0	4	75%
Inter-Mountain Basins Greasewood Flat	S096	0	0	0	0	0	0	0	1	0	0	0	1	0	2	50%
Great Basin Foothill and Lower Montane Riparian Woodland and Shrubland	S118	0	0	0	0	0	0	0	0	0	0	0	0	6	6	100%
	TOT	6	6	5	18	2	59	25	6	22	9	8	4	6	176	
	%ACC	83%	67%	100%	94%	50%	92%	32%	33%	82%	0%	38%	25%	100%		70%

Kappa: 0.603367
Standard error of kappa: 0.0304283
Z-Score for kappa: 19.8291

**Table 6. Fuzzy Set Adjusted Error Matrix: VERY SIMILAR
(Relative Similarity Score = 5 & 4)**

CLASS	S009	S023	S028	S040	S050	S054	S055	S065	S071	S078	S090	S096	S118	TOT	%ACC
S009	5	0	0	0	0	0	1	0	0	0	0	0	0	6	83%
S023	0	4	0	0	0	0	0	0	0	0	0	0	0	4	100%
S028	0	0	5	0	0	0	0	0	0	0	0	0	0	5	100%
S040	0	0	0	17	0	0	0	0	0	0	1	0	0	18	94%
S050	0	0	0	0	1	0	0	0	0	0	0	0	0	1	100%
S054	0	0	0	1	0	58	0	2	0	0	3	1	0	65	89%
S055	0	0	0	0	0	0	20	1	2	1	0	0	0	24	83%
S065	0	0	0	0	0	0	1	2	0	0	0	0	0	3	67%
S071	1	2	0	0	1	0	3	0	20	0	1	1	0	29	69%
S078	0	0	0	0	0	0	0	0	0	8	0	1	0	9	89%
S090	0	0	0	0	0	1	0	0	0	0	3	0	0	4	75%
S096	0	0	0	0	0	0	0	1	0	0	0	1	0	2	50%
S118	0	0	0	0	0	0	0	0	0	0	0	0	6	6	100%
TOT	6	6	5	18	2	59	25	6	22	9	8	4	6	176	0%
%ACC	83%	67%	100%	94%	50%	98%	80%	33%	91%	89%	38%	25%	100%	0%	85%

**Table 7. Fuzzy Set Adjusted Error Matrix: VERY SIMILAR and MODERATELY SIMILAR
(Relative Similarity Score = 5, 4, & 3)**

CLASS	S009	S023	S028	S040	S050	S054	S055	S065	S071	S078	S090	S096	S118	TOT	%ACC
S009	5	0	0	0	0	0	1	0	0	0	0	0	0	6	83%
S023	0	4	0	0	0	0	0	0	0	0	0	0	0	4	100%
S028	0	0	5	0	0	0	0	0	0	0	0	0	0	5	100%
S040	0	0	0	17	0	0	0	0	0	0	1	0	0	18	94%
S050	0	0	0	0	2	0	0	0	0	0	0	0	0	2	100%
S054	0	0	0	1	0	58	0	0	0	0	3	1	0	63	92%
S055	0	0	0	0	0	0	24	0	0	0	0	0	0	24	100%
S065	0	0	0	0	0	0	0	6	0	0	0	0	0	6	100%
S071	1	2	0	0	0	0	0	0	22	0	1	1	0	27	82%
S078	0	0	0	0	0	0	0	0	0	9	0	1	0	10	90%
S090	0	0	0	0	0	1	0	0	0	0	3	0	0	4	75%
S096	0	0	0	0	0	0	0	0	0	0	0	1	0	1	100%
S118	0	0	0	0	0	0	0	0	0	0	0	0	6	6	100%
TOT	6	6	5	18	2	59	25	6	22	9	8	4	6	176	0%
%ACC	83%	67%	100%	94%	100%	98%	96%	100%	100%	100%	38%	25%	100%	0%	92%

**Table 8. Fuzzy Set Adjusted Error Matrix: VERY SIMILAR, MODERATELY SIMILAR, and SOMEWHAT SIMILAR
(Relative Similarity Score = 5, 4, 3, & 2)**

CLASS	S009	S023	S028	S040	S050	S054	S055	S065	S071	S078	S090	S096	S118	TOT	%ACC
S009	6	0	0	0	0	0	1	0	0	0	0	0	0	7	86%
S023	0	6	0	0	0	0	0	0	0	0	0	0	0	6	100%
S028	0	0	5	0	0	0	0	0	0	0	0	0	0	5	100%
S040	0	0	0	18	0	0	0	0	0	0	0	0	0	18	100%
S050	0	0	0	0	2	0	0	0	0	0	0	0	0	2	100%
S054	0	0	0	0	0	59	0	0	0	0	0	0	0	59	100%
S055	0	0	0	0	0	0	24	0	0	0	0	0	0	24	100%
S065	0	0	0	0	0	0	0	6	0	0	0	0	0	6	100%
S071	0	0	0	0	0	0	0	0	22	0	1	1	0	24	92%
S078	0	0	0	0	0	0	0	0	0	9	0	0	0	9	100%
S090	0	0	0	0	0	0	0	0	0	0	7	0	0	7	100%
S096	0	0	0	0	0	0	0	0	0	0	0	3	0	3	100%
S118	0	0	0	0	0	0	0	0	0	0	0	0	6	6	100%
TOT	6	6	5	18	2	59	25	6	22	9	8	4	6	176	0%
%ACC	100%	100%	100%	100%	100%	100%	96%	100%	100%	100%	88%	75%	100%	0%	98%

Table 9. User's Accuracies Relative to Adjusted Fuzzy Set Assessment

USER'S ACCURACY UT-5	Land Cover Class													TOTAL
	S009	S023	S028	S040	S050	S054	S055	S065	S071	S078	S090	S096	S118	
Vry.-Somewhat Similar	86%	100%	100%	100%	100%	100%	100%	100%	92%	100%	100%	100%	100%	98%
Vry.-Mod. Similar	83%	100%	100%	94%	100%	92%	100%	100%	82%	90%	75%	100%	100%	92%
Vry. Similar	83%	100%	100%	94%	100%	89%	83%	67%	69%	89%	75%	50%	100%	85%
20% Validation	83%	100%	100%	94%	100%	67%	57%	67%	60%	0%	75%	50%	100%	70%
No. Samples	6	4	5	18	1	81	14	3	30	2	4	2	6	176

Graph 1. User's Accuracies Relative to Adjusted Fuzzy Set Assessment

