# Stratification of the Environment & Delineation of Ecological Units & Ecological/Range Sites
Exercise 14

The foundation of an effective inventory is the identification of homogeneous populations upon which the inventories will be conducted. In terms of a vegetation inventory the foundation is composed of homogeneous vegetation units.

Arid rangelands, by definition, occur across extensive landscapes containing heterogeneous topographic, soil and vegetation characteristics. The extensive nature of these lands precludes a census and requires a vegetation inventory that utilizes sampling methodologies.
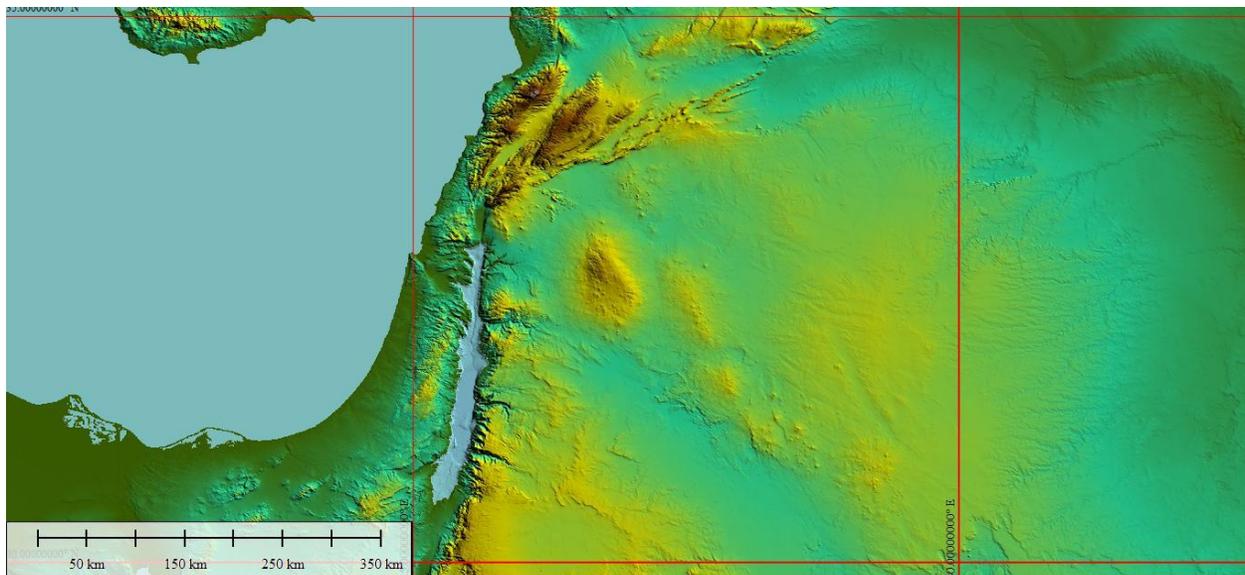
Figure 1. Topography of the eastern Mediterranean region showing variability across the region. Topographic variability, global air circulation patterns, and distance from the sea are controlling variables for vegetation and soil type.

Historically the first step in sampling a heterogeneous landscape would be to stratify the landscape into units based on similarities of use and observed vegetation structure. For example, the initial grazing use may have been used to establish pasture boundaries on the landscape and then a reconnaissance sampling design would have been used to capture basic management data. However, the fact that these pastures are large and contain heterogeneous topographic, soil and vegetation characteristics would limit the use of the pasture unit as the basis for detailed vegetation inventory assessment.   As the demands for improved vegetation inventories increased, the need to classify homogeneous vegetation populations also increased. Initially this classification effort took the form of a visual inspection of vegetation structure within the pasture and the delineation of perceived units of homogeneous vegetation. In other words these early delineations of range vegetation were based on

professional judgment. With time, professional judgment was recognized as being subjective and efforts were made to transition the classification to more objective methods of evaluating vegetation similarity. The Sorenson's similarity index is one example of quantitative comparison.

Figure 2. This is a satellite image (above) and a superimposed soil classification map (below) of Jordan. Notice the variation in the satellite image. Each polygon represents a distinctive soil type. Vegetation and soil characteristics are often closely linked and are often reflective of each other for example soil depth can be indicated by abundance of shallow rooted plant species or the presence of salt tolerant plants can indicate salt affected soils.

Sorenson Similarity Index (%)

$$Index = \frac{(2W)}{(A + B)}$$

Where:

Index = % similarity (decimal form)

W = Amount of attribute in common between stands A and B

A = Attributes of stand A

B = Attributes of stand B

In a generic sense, the classification of rangelands into vegetation units (plant associations) comes under the topic of vegetation classification. A common classification unit used by the US Forest Service is the plant association which is defined as an assemblage of native vegetation in equilibrium with the environment. The definition recognizes that changes in environmental characteristics will change the potential plant association. A plant association is named after dominant species observed in the layers of the vegetation structure (i.e. tree/shrub/herbaceous as in a Ponderosa Pine/ snowberry/elk sedge plant association).

This exercise will illustrate how a similarity index would be used to facilitate the classification of plant associations. In our example stand data for 5 generated stands will be partitioned into plant association units. In our example we will assume that the stands are one tenth acre in size and were selected as being representative of a larger homogeneous area of vegetation. Within each stand a predetermined number of smaller plots were used to evaluate the stand. The attribute measured was frequency (other potential attributes include cover, density or production) and was summarized to yield a measure of species constancy (the portion of plots containing the species) within the stand. The summarized stand data is presented in Table 1:

Table 1. Summary of species constancy within 5 stands.

Species	Stand 1	Stand 2	Stand 3	Stand 4	Stand 5
1	42	28	57	29	43
2	17	50	45	40	61
3	24	44	48	22	54
4	39	32	41	34	30
Total	122	154	191	125	188

The Sorenson Index was applied to all stand combinations (Table 2). An example of the index calculation for stands 1&2 is provided below:

$$Index_{(1,2)} = \frac{2\,(28 + 17 + 24 + 32)}{(122 + 154)} = 0.73$$

Table 2. Index values for 1st generation stand assessments.

	Stand 1	Stand 2	Stand 3	Stand 4	Stand 5
Stand 1	1.00	.73	.78	.83	.73
Stand 2		1.00	.86	.87	.89
Stand 3			1.00	.79	.86
Stand 4				1.00	.77
Stand 5					1.00

The matrix is visually inspected above the center line (1.00). The inspection reveals that Stands 2 and 5 have the greatest level of similarity (similarity 0.89 or dissimilarity 0.11). The stand data from Stands 2 and 5 are then averaged to create a new stand matrix (Table 3) and a 2nd generation of similarity comparisons is generated (Table 4).

Table 3. Stand values for 2nd generation stand assessments.

Species	Stand 1	Stands 2&5	Stand 3	Stand 4
1	42	35	57	29
2	17	55	45	40
3	24	49	48	22
4	39	31	41	34
Total	122	170	191	125

Table 4. Index values for 2nd generation stand assessments

	Stand 1	Stands 2&5	Stand 3	Stand 4
Stand 1	1.00	.73	.78	.83
Stand 2&5		1.00	.88	.83
Stand 3			1.00	.79
Stand 4				1.00

The 2nd generation matrix is visually inspected above the center line (1.00). The inspection identifies that stands 2/5 and 3 have the greatest level of similarity (similarity 0.88, dissimilarity 0.12). The stand

data from stands 2, 5 and 3 are averaged to create a new stand matrix (Table 5) and the 3rd generation of similarity comparisons is created (Table 6).

Table 5. Stand values for 3rd generation stand assessments.

Species	Stand 1	Stands 2/5/3	Stand 4
1	42	43	29
2	17	52	40
3	24	47	22
4	39	34	34
Total	122	176	125

Table 6. Index values for 3rd generation stand assessments

	Stand 1	Stands 2/5/3	Stand 4
Stand 1	1.00	.78	.83
Stand 2/5/3		1.00	.82
Stand 4			1.00

The 3rd generation matrix is visually inspected above the center line (1.00). The inspection identifies that stands 1 and 4 have the greatest level of similarity (similarity 0.83, dissimilarity 0.17). The stand data from stands 1 and 4 are averaged to create a new stand matrix (Table 7) and the 4th generation of similarity comparisons is created (Table 8).

Table 7. Stand values for 4th generation stand assessments.

Species	Stands 1/4	Stands 2/5/3
1	35	43
2	28	52
3	23	47
4	36	34
Total	122	176

Table 8. Index values for 4th generation stand assessments.

	Stand 1/4	Stands 2/5/3
Stand 1/4	1.00	.81
Stand 2/5/3		1.00

The 4th generation matrix is visually inspected above the center line (1.00). The inspection identifies that stands 1/4 and 2/5/3 have a level of similarity of 0.83 (dissimilarity 0.17).

At this point a decision is made to determine the level of dissimilarity that will be allowed in association formation. In this case, 15% dissimilarity was the maximum amount allowed. This is a subjective decision and means that 85% similarity is required for a plant association to be identified.

Table 8. Index values for 4th generation stand assessments.

Stands	Plant Association
2/5/3	Species 2 / Species 3
1	Species 1 / Species 4
4	Species 2 / Species 4

In this exercise, the initial selection of stand sites on the landscape was subjective. The comparison of similarity among stands using a similarity index was objective. The final step of creating plant associations was based on a subjective decision of the acceptable level of dissimilarity that would be allowed in plant association formation. Thus the process is a combination of subjective and objective analysis. To determine the certainty of our plant association delineations we would need to employ statistical comparisons in the form of t-tests, analysis of variance or multivariate statistical tests.

The plant association unit is a common tool in vegetation classification that continues to be used today. However, the process of classification is not static and continues to be refined as more information becomes available. For example, the availability of inventories of environmental attributes allowed individuals to recognize patterns linking environmental attributes with previously identified plant associations.   As a result the plant association can and has been further delineated into units such as the ecological site which is the vegetation classification unit used by the Natural Resource Conservation Service and Bureau of Land Management. The ecological site is defined as a distinctive kind of land with specific physical characteristics that differs from other kinds of land in its ability to produce distinctive kinds and amounts of vegetation.

Ecological sites are created by overlaying plant associations with zones of effective precipitation. The zones are recognized at the landscape scale and are created by delineating ranges in elevation, North vs South aspect, topographic slope, soil depth and soil texture patterns. Similar to the plant association, ecological site delineation was begun using professional judgment to partition the landscape. The subsequent application of quantitative comparisons of similarity has reduced the level of subjectivity in unit identification but existing delineations will require a future assessment of certainty to verify their classification.