Measuring Species Diversity

1. **Definition**.
   a. Difficult to define because definition consists of two distinct components:
      i. Species Richness =Variety of species or the number of different species (or genera, families, etc.).
      ii. Species Abundance = Relative abundance of species
   b. **Species Richness** = an index based on the number of species
      i. Numerical species richness = number of species per specified number of individual
      ii. Species density = number of species per unit are
      iii. Simple and easy to calculate and therefore intuitively appealing.
      iv. However, because it does not account for relative abundance, it is often not sensitive to environmental disturbance.
   c. **Species Abundance or Evenness** = Describes relative abundance of species.

2. **Benefits of Diverse Range Plant Community:**
   a. A mixture of plants provides forage for a variety of insect and vertibratel species (biodiversity)
   b. A mixture of plants will contain some plants that can survive drought, insect plagues, and/or disease outbreaks so that the site will have some soil protection/forage/etc. in those years
   c. A mixture of plants contains a variety of genetic material that may be useful in long-term survival.
   d. The community benefits from a mixture of plants (soils improve with nitrogen fixers, deep rooted plants bring nutrients up from soil layers below other plants roots, some species work together so that both can survive - commensalism)
   e. Healthy diverse plant communities generally have all niches filled and are theoretically less likely to be invaded by noxious or opportunistic introduced species.

Disadvantages of Diverse Composition in the Range Plant Community:

   f. It becomes more difficult to manage because different species of plants have different grazing tolerances and different rates of phenological development.
   g. Not all plant species are desirable for all foraging species.
   h. Diverse communities are often a sign of fragmented or somewhat degraded site where much of species richness is contributed by disturbance species.

Diversity Indices - that combine both richness and abundance

   i. Shannon-Wiener Index (H')
      i. Most commonly used index in ecological studies
      ii. Values range from 0 to 5, usually ranging from 1.5 to 3.5
      iii. Calculated: $H' = -\sum\left[\left(\frac{n_i}{N}\right)\times\ln\left(\frac{n_i}{N}\right)\right]$

iv. Where n_i = number of individuals or amount (e.g. biomass) of each species (the *ith* species) and *N* = total number of individuals (or amount) for the site, and ln = the natural log of the number.

v. Advantages and Disadvantages:

(1) Relatively easy to calculate

(2) Fairly sensitive to actual site differences

(3) There are several instances where *H'* is similar between sites even though sites are different.

j. Simpson's Index (λ) -

i. λ is a measure of dominance therefore, (1-λ) measures species diversity

ii. Gives the probability that any two individuals drawn at random from an infinitely large community belong to different species

iii. Calculate: $\lambda = \sum \frac{n_i(n_i - 1)}{N(N-1)}$

iv. Where n_i = number of individuals or amount of each species (i.e., the number of individuals of the *ith* species) and *N* = total number of individuals for the site.

v. Advantages and Disadvantages:

(1) Less sensitive to species richness and heavily weighted towards the most abundant species

(2) Generally less sensitive than Shannon-Weiner H'

3. **Similarity Indices** - measure similarity between communities based on species composition.

i. Useful in comparing communities under different management.

ii. Can also be used to compare composition changes over time (e.g. determine how similar the communities is to what is was 10 years ago... If data exist)

iii. Similarity indices overcome some short comings such as:

(1) When communities are very different comparing diversity indices may not be meaningful

(2) Diversity indices often don't change for sites with similar species but different proportions.

iv. Similarity Index

(1) Values range from 0 to 1 with the higher value suggesting greater similarity

(2) Calculate: $Sim = \frac{2 \sum nc}{\sum n1 + \sum n2}$

(3) Where *nc* = the common species between sites; *n1*= the species of site 1 and *n2* = species of site 2

(4) When cover is being used, similarity is simply ∑ cover in common for each spp.