National Pingtung University of Science and Technology

Department of Soil and Water Conservation

Vegetation and Environmental Conservation Laboratory

Vegetation Survey and Analysis

Dr. Chih-Wei Chuang

E-mail: markchuang@mail.npust.edu.tw

Outline

- Types of Vegetation Survey
- Qualitative survey of plant communities
- Quantitative survey of plant communities
  - Key Points for Sample Area Sampling Survey Method
  - Sample Area Sampling Survey Items and Methods
  - No Sample Area Sampling Survey Method
- Analysis and Application of Vegetation Data

Types of Vegetation Survey

Purpose

The purpose of vegetation survey is to derive all clusters and their attributes of plant society within an area , study and analyze the composing individuals and their sizes , number, arrangement, etc. and mutual relationships of these plant communities , and further conjecture competitive situation of species, and possible succession development of the plant society.

Category Definition

Vegetation survey often uses sample area data to conjecture the attributes of the parent population, speculate the overall characteristics of the vegetation community with fewer survey data, and use them as a reference basis. Vegetation survey categories can be summarized into flora survey and plant community survey respectively.

Types of Vegetation Survey

Category Definition(Continued)

1.Flora survey

Flora survey is using all plant species in a certain area as the target to conduct the collection and judgment and interpretation works of the plants, record or estimate basic data of each species, such as attributes, number of population, distribution and breeding environment, and conditions, etc., and study and analyze the characteristics such as size, number, arrangement and their mutual relationships of the composing individuals (specifically dominant species) of the plant community.

Types of Vegetation Survey

Category Definition(Continued)

2. Vegetation community survey

Taking vegetation community as the survey target, set up sample areas of the vegetation community in a homogeneous environment, record species, composition structure, and distribution of the plants in the survey sample areas, and investigate tree height and chest height diameter of the main dominant plants as needed for the reference of analyzing vegetation community patterns, producing vegetation diagram and vegetation community sectional diagram, and conjecturing plant succession, mutual relationships between populations. The vegetation community survey can be divided into a vegetation qualitative survey and a vegetation quantitative survey.

Qualitative survey of plant communities

Plant qualitative survey is to investigate the characteristics of plant society according to the degree of homogeneity and use dominant plant species as the representative of vegetation community. And it is usually done by subjective observation on the composition of a plant community to give the traits of the plant s in accordance with the characteristics described, and afterward can indirectly understand local environmental characteristics through the plant traits.

(1)Degree of clustering of the vegetative individuals (sociability)

The sociability of plant population refers to the degree of clustering of the individuals of the plant population , i.e., the relative gregariousness or clumping of the individuals of the plant population. The sociability can be divided into five grades as described in detail in Table.

Qualitative survey of plant communities

Plant population society grading table

Grade	Degree of Clustering	Growth Pattern
First Grade (soc.1)	Growing alone	Growing solitary, single
Second Grade (soc.2)	Growing in clusters	Forming clumps or dense groups
Third Grade (soc.3)	Growing in patches or cushions	Forming small patches or cushions
Fourth Grade (soc.4)	Growing in small groups	Growing in small colonies or forming larger carpets
Fifth Grade (soc.5)	Growing in large groups	Growing in larger, almost pure population stand

Qualitative survey of plant communities

(2) Structural (hierarchical) characteristic of vegetation community

Plant community generally has certain biological composition has hierarchies on biodistribution, and has circadian rhythm and seasonal changes, and increase and decrease phenomena in terms of time. In addition, various bio s are mutually dependent, mutually influencing, and their respective environment and biological population has a close mutual influence relationship.

Quantitative survey of plant communities

1. Key Points for Sample Area Sampling Survey Method

Vegetation quantitative survey method is to select appropriate sample areas in the survey region according to environment, life forms of plants, canopy structure and distribution and survey purposes and other conditions to conduct the investigation of the species, numbers and growth situations of plants, and then carry out combinatorial analysis in accordance with the parameters obtained from survey as a method for calculating the characteristics of vegetation community.

The setting of survey sample areas need to consider the area characteristic factors such as sample area shape, sample area orientation, distribution pattern of sample areas, minimum area of sample area, and minimum number of sample areas.

Quantitative survey of plant communities

A. Selection of sample area shape

The selection of sample area may vary depending on the terrain and the convenience of the survey. Generally, square, rectangular, strip-shaped cross-sectional areas or line-like sample area (line-intercept method) are commonly used shapes.

Source:
Catchment Area Vegetation Community Survey Application Handbook, 2008

Quantitative survey of plant communities

B. Orientation and distribution of sample areas

The setting of sample areas also must consider their orientation, i.e., the arrangement direction of long or short axis.

- If the plant society is homogeneous, the orientation has less influence, however, in general mountain areas the flora slightly changes in gradient due to the topography, so the selection of long axis should cross the changed gradients in order to obtain accurate (smaller variation) data.
- If the survey region is a large-scale vegetation community and not a single plant society, then objective synthesis method is commonly used to set sample areas, and the obtained sample area data are classified in order to construct a mosaic structure.

Quantitative survey of plant communities

C. Area of sample area

When conducting sampling survey, **first** must determine that how much the area of the sample areas should be set . In general, when selecting the area of the sample areas, in addition to considering whether the plant community composition is homogeneous, must also consider the life forms o f the vegetation community. When selecting the size of the sample areas , can choose a appropriate method to determine the size of the sampling areas according to the rule of thumb, (Lin Xinhui, 2008). When conducting vegetation community survey , the minimum required area of sample areas is determined by the richness of plant species.

Quantitative survey of plant communities

Minimum area of sample area of category vegetation community survey

Vegetation community category	Minimum area of sample area (m^2)
Herb layer	1-2
Low shrub and high herb layers	4
High shrub layer	16(4X4)
Arbor layer	100(10X10)

Quantitative survey of plant communities

D. Number of sample areas

In general, the number of sample areas must be decided by changes in vegetation community logistic time, budget and manpower etc. However, in accurate vegetation community survey , the area of the sample areas accounted for the percentage of the research region should be determined first. At the same time, should consider how many vegetation groups are seen during exploration , and each vegetation group should not only be covered at the time of sampling, but also should be repeated , because the number of sample areas will affect the accuracy of the survey. And in the determination of the appropriate number of sample areas the “species number sample area number curve” method is mostly used. This method is similar to the species number area number curve method, i.e., using the plant relationship between the number of species and the number of sample areas to conduct the plot ting, research and analysis.

Quantitative survey of plant communities

2. Sample Area Sampling Survey Items and Methods

A. Quantitative media of vegetation survey

The more commonly used parameters for quantifying vegetation community include density, frequency, coverage or dominance.

a) Density

Refers to the number of plant individuals per unit area. Its calculation is usually expressed in terms of number of plants per m^2 or ha.

b) Frequency

Refers to the number of occurrences of a certain plant in each set sample area or sample point. It is usually expressed as the ratio of the number of plants recorded in the sample area during survey to the total number of plants recorded in total sample areas set.

Quantitative survey of plant communities

c) Coverage

Coverage is the ratio of the projected area of canopy or branches of a plant to the area of the ground surface, often expressed as a fraction or percentage. It is usually used to compare the difference between the ratios of the spaces occupied by different plants within a vegetation community, and as a parameter of the dominance of plant in the breeding area.

Coverage grade distinction

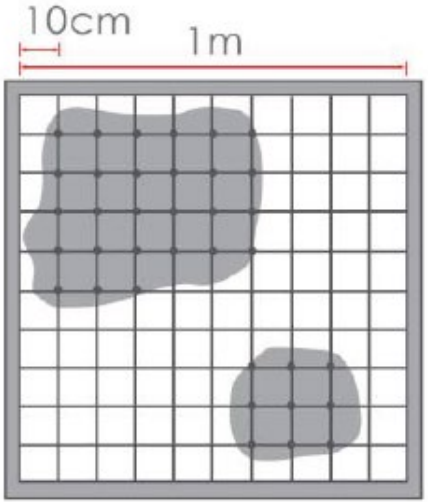
Grade	Coverage area percentage (%)
Grade A	Less than 5
Grade B	6~25
Grade C	26~50
Grade D	51~75
Grade E	76~100

Quantitative survey of plant communities

3. No Sample Area Sampling Survey Method

- The point intercept method is also called the point quadrat method. Its principle is when estimate the plant coverage, draw the covered profile of the plant onto a square grid paper, and then calculate the number of squares occupied by it, and the obtained result is calculated as the coverage of the plant.
- When measuring , the applicable tool is point frequency frame, this frame is usually made of wood (both height and length are 1m) and has ten wire pins with a length equal to bracket and interspersed from the holes. Because of being limited by height, this frame is only applicable to herbaceous plants or low lying shrub groups having a general height (20~50c m).
- When sampling, only location factor is necessary to be considered. Because no boundary and area restrictions, so it is the most simple, quick survey method, however, in general it is better used to investigate low layer plants.

Quantitative survey of plant communities



Point frequency frame Total 100 intersect points

Description: Species A coverage = 36/100 = 36%

The board frame used in point-intercept method (Source: Lin Xinhui, 2016)

Analysis and Application of Vegetation Data

1. Calculation of Importance and Diversity of Species

A. Calculation of important value index (IVI)

- The plant society parameter is expressed as important value index (IVI). The plant society is divided into upper and lower layers (the arbor layer and the ground cover layer), and the density, frequency and dominance of various plants in each sample area are calculated, and then converted into relative values.
- The important value of the upper layer plant society is the sum of the relative values of the three.
- The important value of the lower layer plant society is the sum of the relative frequency and relative dominance.

Analysis and Application of Vegetation Data

1. Calculation of Importance and Diversity of Species

A. Calculation of important value index (IVI) (Continued)

$$Arbor\ layer\ dominance = \frac{Sum\ of\ projection\ areas\ of\ certain\ plant's canopy\ (or\ the\ chest\ height\ cross\ section\ area)}{Total\ number\ of\ sample\ areas\ surveyed}$$

$$Ground\ cover\ layer\ dominance = \frac{Sum\ of\ coverage\ areas\ of\ certain\ plant}{Sum\ of\ areas\ of\ sample\ areas\ surveyed}$$

$$Relative\ density(\%) = \frac{Density\ of\ certain\ plant}{Sum\ of\ density\ of\ all\ plants} \times 100\%$$

$$Relative frequency(\%) = \frac{Frequency\ of\ certain\ plant}{Sum\ of Frequency\ of\ all\ plants} \times 100\%$$

$$Relative\ dominance(\%) = \frac{dominance\ of\ certain\ plant}{Sum\ of dominance\ of\ all\ plants} \times 100\%$$

Analysis and Application of Vegetation Data

1. Calculation of Importance and Diversity of Species

A. Calculation of important value index (IVI) (Continued)

$$Relative\ density(\%) = \frac{Density\ of\ certain\ plant}{Sum\ of\ density\ of\ all\ plants} \times 100\%$$

$$Relative frequency(\%) = \frac{Frequency\ of\ certain\ plant}{Sum\ of Frequency\ of\ all\ plants} \times 100\%$$

$$Relative\ dominance(\%) = \frac{dominance\ of\ certain\ plant}{Sum\ of dominance\ of\ all\ plants} \times 100\%$$

- Arbor layer IVI = Relative density + Relative frequency + Relative dominance (total is 300)
- Ground cover IVI = Relative frequency + Relative dominance (total is 200)

Analysis and Application of Vegetation Data

1. Calculation of Importance and Diversity of Species

A. Calculation of important value index (IVI) (Example)

Species	Number of plants	Relative Density(%)	Frequency	Relative Frequency(%)	Dominance (%)	Relative Dominance(%)	IVI
A	2	4.00	2	5.41	10	10.00	19.41
B	4	8.00	4	10.81	15	15.00	33.81
C	15	30.00	8	21.62	22	22.00	73.62
D	2	4.00	2	5.41	4	4.00	13.41
E	2	4.00	2	5.41	5	5.00	14.41
F	10	20.00	8	21.62	19	19.00	60.62
G	11	22.00	8	21.62	20	20.00	63.62
H	4	8.00	3	8.10	5	5.00	21.1
Sum	50	100.00	37	100.00	100.00	100.00	300.00

Analysis and Application of Vegetation Data

1. Calculation of Importance and Diversity of Species

B. Calculation of species diversity index

For a plant society, if its constituent components are more complex, the more it can withstand the interference of external forces. Conversely, if the species of a plant community is quite simple, once the dominant plant species of the plant community suffers interference, then the impact on the whole plant community would be extremely serious. The complexity of a plant society is use species diversity index to express.

Analysis and Application of Vegetation Data

1. Calculation of Importance and Diversity of Species

B. Calculation of species diversity index (Continued)

◆ Species richness (R)

$$R = \frac{S}{N}$$

S: Total number of species appear in the plant society under survey.

N:Total number of individuals (number of plants) appear in the plant society under survey.

◆ Simpson index of diversity (Dsi)

$$Dsi = 1 - \sum(\frac{n_i}{N})^2 = 1 - \sum(p_i)^2$$

ni: Number of individuals of i-th plant species.

N: Sum of number of individuals of all plant species of the plant society.

Pi= ni/N: Probability of occurrence of each species

Analysis and Application of Vegetation Data

2. Analysis of Vegetation Communities

A. Vegetation community similarity

In order to compare the similarity of two plant communities, Motyka et al (1950) had used parameters such as species dominance to calculate Smo similarity index to compare two plant communities of the region.

$$Smo = \frac{2Nw}{Na+Nb} \times 100\%$$

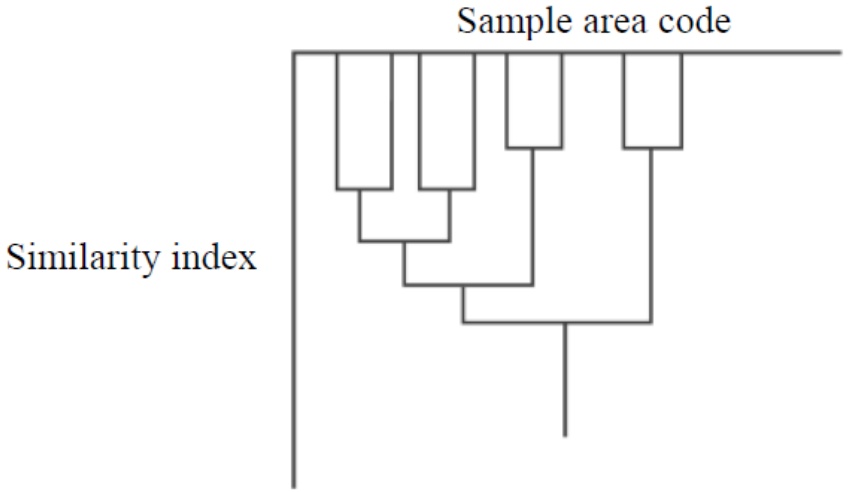
Where
Na=Total number of individuals in the A sample area community
Nb = Total number of individuals in the B sample area community
Nw = Sum of the fewer individuals in the common species of the two sample areas

Analysis and Application of Vegetation Data

2. Analysis of Vegetation Communities

B. Matrix cluster analysis

Conduct matrix cluster analysis according to the above calculation of community similarity indexes between different survey sample areas. The vegetation communities in the survey region can be grouped, and at last the distribution of vegetation communities in the survey region is expressed in a dendrogram.



Prototype of dendrogram

Analysis and Application of Vegetation Data

3. Normalized Difference Vegetation Index

Normalized Difference Vegetation Index (NDVI) is the ratio of the difference of near-infrared light band and red band to the sum of these two bands, can be used to judge the much or few of vegetation reflection amount and monitor vegetation changes. The calculation principle of normalized difference vegetation index is based on the characteristics that healthy green vegetation has strong reflection in near-infrared light and photosynthesis has strong absorption for red light. The formula is generally expressed as follows:

$$NDVI = \frac{NIR - R}{NIR + R}$$

Where
NIR: Near-infrared light reflection value
R: Red light reflection value

Reference

Soil and Water Conservation Bureau (2017) Soil and Water Conservation Handbook (Agronomy Chapter).

Thanks for your attention.