RESEARCH PROPOSAL SUBMITTED TO AL WIEDEMANN AND STEVE HERMAN

by

J.R. Acker
R. Gerrish
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TITLE

VEGETATION-SOIL RELATIONSHIPS OF A FOREST COMMUNITY IN THE TSUGA HETEROPHYLLA ZONE OF WESTERN WASHINGTON.

Proposed starting date: January 2, 1973

Projected completion date: April 16, 1973

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Objectives

The primary objective of the project is to discover whether or not different forest communities exist within the research area. If various communities do occur, then the relationships within and between the communities will be determined. These communites will be studied with regard to soil properties and soil organisms. The history of the study area will be researched to ascertain past natural and man induced environmental changes.

Introduction

Vegetation Analysis

The study area is located in the southernPuget Sound region and is representative of the Tsuga heterophylla Zone. According to Franklin and Dyrness (1969) this zone is the most important with regard to timber production. This region is well known for subclimax Pseudotsuga mensiesii and climax Tsuga heterophylum-Thuja plicata formations (Weaver and Clements 1938; Oosting 1956; Cooper 1957). The Tsuga heterophylla Zone in Washington extends south from British Columbia through the Olympic Peninsula, Coast Ranges, Puget Trough, and both Cascade physiographic provinces in Western Washington.

Thurston County, lying at the southern end of the Puget Trough, was first settled in 1845. In this same year logging operations were begun and continued throughout the 1850's until all the original stands of Pseudotsuga manziesii were removed (Soil Survey, 1951). It must be noted that although it is named the Tsuga heterophylla Zone based on the potential climax species, large areas are dominated by forests of Psedotsuga menziesii (Franklin and Dyrness, 1969). Thurston County was extensively logged again in the 1940's (General Knowledge). Due to this repeated logging Pseudotsuga is found to be a dominant (often

sole dominent) in the seral stands that have developed (Munger 1930, 1940).

The climate of Thurston County is temperate and marine with little fluctuation in seasonal temperature. Mean annual temperature is 10.5 C, and neither January nor July temperature are extreme. Percipitation averages 1281 mm. per year and occurs mainly during the winter months. Summers are relatively dry with only 6 to 9 percent of the total percipitation (Soil Survey,1947).

The forest communities of the Tsuga heterophylla Zone have been studied in detail at many locations. These studies are as follows; (1) community classifications of seral Pseudotsuga menziesee stands (Spilsbury and Smith 1947; Becking 1954, 1956), (2) communitydescriptions for limited areas (Dirks-Edmunds, 1947; Macnab, 1958; Merkle, 1951; Anderson 1967), and (3) investigations of the entire forest communities (Bailey 1966; Orloc, 1965; Corliss and Dyrness 1965; Rothacher et al. 1967; Fonda 1967). Bailey and Poulton (1968) and Mueller-Dombois (1965) concentrated upon seral communites, McMinn (1960) upon community moisture relationships, and Eis (1962) upon community correlations with environment and productivity. Cryptogamic components of forests in the Tsuga heterophylla Zone have been reported by Pechanec (1961), Higinbotham and Higinbotham (1954), Spilsbury and Smith (1947), Orlozi (1965), and Becking (1954).

The more comprehensive studies have shown a similar spectrum of communities arranged along moisture gradients. The same basic pattern of Gaultheria-Berberis-Polystichum is repeated throughout the zone (Franklin and Dyrness 1969).

The area that has been selected for this study is located on the

southern portion of The Evergreen State College (Fig. 1). The campus is located five miles west of Olympia in Thurston County, Washington. This particular forest area was selected in order to contribute to the continuing biological study of The Evergreen State College campus.

Two previous studies of the vegetation on The Evergreen State College have been conducted: the first being a general discriptive study of the campus (Winje and Otto,1972) and the second being a description of the college's shoreline property (Brockway and Williams, 1972).

Soil Analysis

General soil survey work has a long history, coming into its own in 1899 when the first United States Soil Survey began. Early texts on soil properties and survey work started to appear around the 1920's; one of the earliest being Nature and Properties of Soils by Lyon and Buckman published in 1922. The United States Department of Agriculture, in an attempt to standardize much of the survey work being done, published its first handbook in 1937 and made subsequent revisions of it in 1950.

Much of the soil survey work today is carried out either at land-grant colleges or universities, or by government agencies such as the Soil Conservation Service. In 1947 this agency completed a thorough soil survey of Thurston County. The survey gives detailed description and map locations of 133 soil units that represent 51 series and 6 miscellaneous land types. The descriptions also relate the soils to the general surrounding vegetation. However, no research into the possible relationships between soils and the existing vegetation started until the late 1950's and early 1960's. Works done in this

field of study have dealt with soil moisture - vegetation relationships (Daubenmire, 1968; Branson, Miller and McQueen, 1965); soil depths relative to vegetation communities(Hullet et al., 1969), soils related to Pinus ponderosa stands (Dyrness and Youngberg, 1966); soil-vegetation relationships in southeastern Utah (West and Ibrahim,1968); and wood's vegetation in relation to soils in Indiana (Beals and Cope, 1964). To our knowledge only limited studies in this field have been made in the Tsuga heterophylla Zone of Western Washington (Forest Soils Committee of the Douglas fir Region, 1957; Duane and Tarrant, 1968).

Another aspect of soil analysis deals with soil invertebrates of the phylum Arthropoda and their relationships to vegetation. Work done with arthropods has concerned itself primarily with identification and physiology, resulting in the naming of some 600,000 species (Cloudsley-Thompson, 1958). At the present time no studies of soil arthropod-vegetation relationships in the Tsuga heterophylla Zone are known.

Dendrochronology

Dendrochronology was begun in 1904 by A.E.Douglas, an astronomer, who was studying sunspot cycles. By correlating known past weather conditions with tree rings he was able to develop a master chronology that demonstrated the effects of of sunspot cycles upon climatic conditions. Tree ring patterns yield information concerning past climatic conditions, diseases, insect infestations, and factors affecting growth. Dendrochronology also has been used extensively in determining the age of forest stands. (Stokes and Smilex, 1968; White, 1966; McGinnies, 1967; Smith, 1966; Giddings, 1941) Anything done in the northwest?

Research Goals

The research goals will be concerned primarily with the analysis

and description of the forest community and relationship of soil properties and organisms to the community. The study will encompass the determination of the various communities that exist within the sampling area and the site type that is associated with each. It will require a mapping of the area with regard to community parameters and environmental features.

The specific goals of the soil analysis work are to gain an understand- of the physical properties and the arthropod populations of the soil within the study area. By test and field observations the soil will be placed into type and phase classification, and mapped to determine the extent and location of the soil units. With regard to classification, the soil survey work will be studied in relation to the findings of the vegetation analysis.

Dendrochronology will be used in our research to determine the age of the forest stands found in the research area. It is expected that the core samples taken will show sensitive ringpatterns which will facilitate the plotting of a master chronology. This masterchronology will give information concerning periods of time when the community growth was hampered or enhanced. Combining our study of the past history of the area with the master chronology, we will be able to discover when natural or man caused disturbances took place in the area and the effects of them upon the area.

Field Procedures

Vegetation Analysis

The study areawill be sampled by use of the quadrat method (Oosting 1956; Cain and Castro 1959) with the quadrats systematically distributed (Oosting 1956; Greig-Smith 1964). In order to establish the location of gradients, evenly spaced transects will traverse the study area.

There will be 10 transects traversing east-west; each being 75m. apart. The southern-most and northern-most transects will be inset 37.5m. from their respective border. There will be 16 transects running north-south with 60m. intervals. There will be a 30 m. inset from the eastern and western borders. There will be 160 transect inersections representing the quadrat centers.

Each quadrat will be 8x8 meters. Originally it was planned to use the standard 10x10m. quadrat (Oosting 1958; Cain and Castro 1959); however, initial observation the forest proved to be quite dense resulting in the overlooking of some species and the duplicate accounting for others when utilizing the 10x10m. quadrat. The utilization of the 8x8m. quadrat eliminated the above inaccuracies appreciably.

In order to obtain possible data concerning forest canopy regeneration all tree species will be classified as follows:

Mature trees- greater than 7 cm. DBH

Pole - greater than 5cm. but less than 7cm. DBH

Saplings - less than 5cm. DBH but taller than 1m.

Seedlings - less than 1m. in height

is it reasonably consistent, however, with "standard" usage?

The above classification was arbitrarily established in order to facilitate ease in data collection. The individual diameter of all the trees within the quadrats will be recorded; whereas, only the total number of poles, saplings, and seedings will be recorded.

The northeast quarter of each quadrat will be used for shrub cover determination. This determination will consist of a visual estimate of the percentage of the area covered by each species and divided into the following classes (Merkle, 1951):

Class 0 - less than 1% coverage

Class 1 - 1% to 5% coverage

Class 2 - 6% to 25% coverage

Coverage by stem or by "leaf" circumference?

Class 3 - 26% to 50% coverage

Class 4 - 51% to 75% coverage

Class 5 - 76% to 100% coverage

restrictions? procedures?

Due to a substantial number of forked trees in our study area, it has been necessary to develop some guidelines concerning the counting of such trees. The guidelines are as follows: 1) trunks which fork at ground level or below will be considered as separate trees and measured as such; 2) trunks which fork above the ground but below breast height will each be measured; however, the total area will be recorded as one tree and will be indicated on the data sheet as such.

Density, frequency, dominance and importance values will be determined for each species of tree; whereas, only frequency and dominance for shrubs will be determined.

Soil Analysis

Two soil samples will be taken from each quadrat in a systematic manner to ensure consistency in procedures. A circle, 80cm. in diameter, placed in the northwest cornor of the northeast quarter of the quadrat will designate the sampling area. A "loose" sample, weighing approximately 250 g. will be taken from the top 15 cm. excluding the O_1 horizon. From every third quadrat a loose sample of the top 15 cm. inclusive of the O_1 horizon will be taken and used for analyzing arthropod populations. (Buckman and Brady, 1967; Soil Survey Manual, 1951) Soil depth determination will be the only field conducted test. Utilizing an orchard-auger the soil will be probed until bedrock or a definite base of the profile is reached. This data will be recorded in the field and will include any important visual characteristics of the soil.

If time allows, at the conclusion of the project a soil monolith will be taken from each soil unit for closer study.

ndrochronology

Core samples, 4.8mm. in diameter, will be taken at standard breast height from the largest dominant or co-dominant species in each quadrat. Cores will also be taken from the more uncommon species of the area, such as Taxus brevifolia or Arbutus menziesii. Each sample, taken with a Swedish Increment Borer, will be placed in a protecting soda straw and tagged with regard to species, quadrat, and sampler's name. The resulting hole in the sampled trees will be plugged with cork and painted to prevent insect infestation.

Laboratory Procedures

Soil Analysis

Four tests will be conducted on two of the field samples to obtain physical properties of the soil. The 15 cm. sample will be divided into two equal portions for pH and organic matter determination.

1) pH will be tested in two manners - soil paste and 1:5 soil-water suspension both being measured with an electric pH meter (Soil Survey Manual, 1951)
2) Organic matter tests will follow the procedures outlined by Cox, 1967, see Appendix I.

The 45cm. core sample will be utilized for bulk density and soil-separate analysis.

1) Bulk density test will follow the procedure outlined by Harder and Johnson, 1970, see Appendix II.
2) Soil-separate analysis will follow the procedures outlined by Cox, 1967, see Appendix III.

All data will be recorded on a data sheet for use in computer anaylsis, classification, and mapping.

The samples taken for arthropod analysis will be placed in Tullgren funnels for four days. At this time, the extracted sample will be

amined with the use of disecting microscopes; populations will be identified and counted; and the data recorded.

Dendrochronology

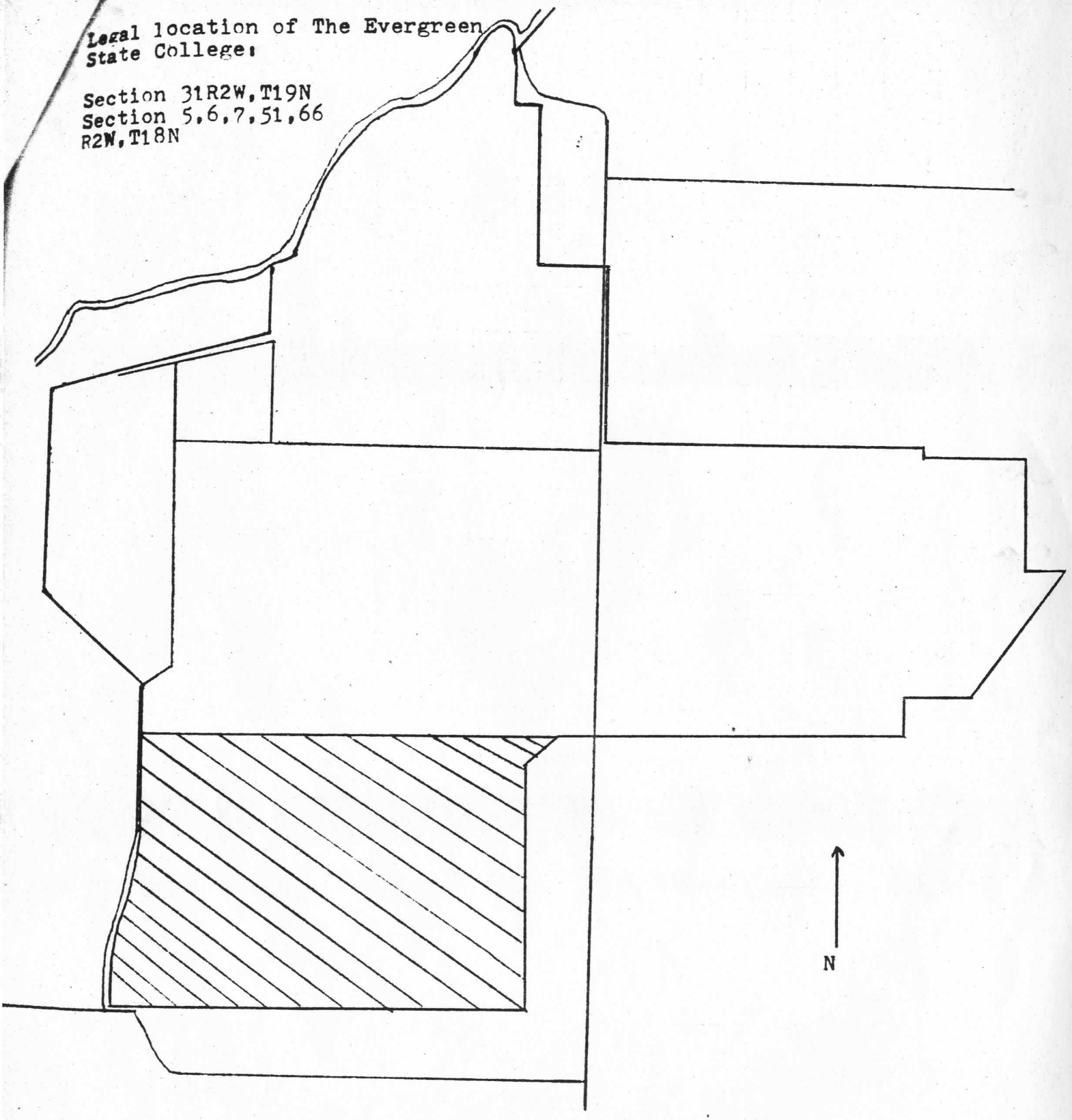
The laboratory procedure for analyzing the core samples collected is outlined by Cox, 1967. The procedure is as follows:

1) Label and mount core sample with regard to species and gradient.
2) Allow samples to dry and sand.
3) Examine under disecting microscope to measure ring widths and to observe ring patterns.
4) Record data for use in compiling the master chronology plot.

Preparations

A vegetation analysis data sheet has been tested in the field and subsequent revisions made. Preliminary studies pertaining to the survey work have been conducted and the legal descriptions made by contracted surveys have been obtained. Computer programs associated with the various analysis of data have been developed and formulated. Taxonomic research has been conducted especially in regard to winter twig identification. Much of the effort concerned with advance preparation has delt with the reading and collection of related research projects.

Figure #1



lacks distinction in map

The Evergreen State College boundary
Improved roads
Study area

Literature Review

nderson, Howard George. 1967. The Phytosociology of Some Vine Maple Communities in the Mary's Peak Watershed. 118 pp., illus. (Unpublished M.S. thesis on file at Oregon State University, Corvallis)

Bailey, Arthur Wesley. 1966. Forest Associations and Secondary Plant Succession in the Southern Oregon Coast Rangs. 164 pp. (Unpublished Ph.D thesis on file at Oregon State University, Corvallis. Abstract in Dissertation Abstract, Section B 27(8): 2605B-2606B. 1967.

Baker, E.W. and others. 1952. An Introduction to Acarology. New York, Macmillan.

Baker, E.W. and others. 1958. A Guide to the Families of Mites. Cont.#3 Institute of Acarology, Department of Zoology, University of Maryland.

Beal, E.W. and Cone, J.B. 1964. Vegetation and Soils in Eastern Indiana Woods. Ecology : 777-792. Autumn

Becking, Rudolf Willem. 1954. Site Indicators and Forest Types of the Douglas Fir Region of Western Washington and Oregon. 133 pp., illus. (unpublished Ph.D thesis on file at University of Washington, Seattle.)

Becking, R.W. 1956. Die Naturlichen Waldgeschellschaften Washingtons and Oregons. Allgem Forest a Jagdz, 127: 42-56.

Borror, D.J. and D.M. Delong. 1964. An Introduction to the Study of Insects. New York, Rinehart & Wilson.

Brady, Nyle C. and Buckman, Harry O. 1969. The Nature and Properties of Soils, 7th edition. Toronto, Macmillan.

Branson, F.A. and others. 1965. Plant Communities and Soil Moisture Relationships near Denver. Ecology: 311-319. Spring

Brockway, Mariel and Anrski Williams. 1972. Vegetation Study of TESC Shorefront Property. On file at the Evergreen State College, Olympia.

Cain, S.A. and Castro G.M. 1959. Manual of Vegetation Analysis. New York, Harper.

Chu, H.F. 1949. How to Know Immature Insects. Dubuque, Iowa. W.C. Brown Co.

Cloudsley-Thompaon, J.L. 1958. Spiders, Scorpions, Centipedes and Mites. New York, Pergamon Press.

Coile, T.S. 1936. Soil Samplers. Soil Science 42: 139-142.

William S. 1957. Vegetation of the Northwest Province. Proceedings of the Eighth Pacific Science Congress. 8 (4): 138

..., J. F., and Dyrness, C. T. 1965. A detailed soil-vegetation survey of the Alaska area in the Oregon Coast Range. In Forest-soil relationships in North America, ed. by C. T. Youngberg, pp. 457-483, illus. Corvallis, Oregon State University Press.

Cox, G. W. 1967. Laboratory Manual of General Ecology. Dubuque, Iowa W. C. Drown Co. pp.163

Daubenmire, R. 1968. Soil moisture in relation to vegetation distribution in the mountains of Northern Idaho. Ecology (Late spring)pp. 445-456

Dirks-Edmunds, Jane C. 1947. A comparison of biotic communities of the cedar-hemlock and oak-hickory associations. Ecology Monograms 17: 235-260 illus.

Dyrness, C. T. and Franklin, Jerry F. 1969. Vegetation of Oregon and Washington. USDA Forest Service Research Paper PNW-80 216 pp. Illus.

Dyrness, C. T. and Youngberg, C.T. 1966. Soil-vegetation relationships within the Ponderosa Pine type in the Central Oregon pumice region. Ecology(Winter and Early Spring) pp. 122-138

Eis, Slavoj. 1962. Statistical analysis of several methods for estimation of forest habitats and tree growth near Vancouver, British Columbia. University of British Columbia Facility of Forestry, Forestry Bulletin #4, 76 pp. illus.

Emerton, J.H. 1961. The Common Spiders of the U.S. New York Dover Publications 227 pp.

Essig, E.O. 1958. Insects and Mites of Western North America. New York, Macmillan Publishing Co.

Fonda, Richard Weston. 1967. Ecology of Montana and sub-alpine forests in the Olympic Mountains, Washington. 145 pp. illus. (unpublished Ph.D. thesis on file at the University of Illinios, Urbana)

Greig-Smith, Peter. 1964. Quantitative Plant Ecology. Washington, D.C. Butterworth Company 256 pp.

Higinbotham, N. and Higinbotham, Betty Wilson. 1954. Quantitative relationships of terrestrial mosses with some coniferous forests at Mt. Rainier National Park. Butler University Botanical Studies 11: 149-168

Hollet, K.K. and others. 1969. Soil depth-vegetation relationships

on a shallow limy range site in Western Kansas. Journal of Range Management (May) pp. 196-199

Ibrahim, K.I. 1968. Soil-vegetation relationships in the Shadscale Zone of Southwestern Utah. Ecology: 445-456.

Kershaw, Kenneth Andrew. 1964. Quantitive and Dynamic Ecology. New York, American Elsevier, 133p.

Kevan, D.K. 1955. Soil Zoology. New York, Academic Press.

Kunnel, T.W. 1961. Soil Biology. Faber.

MacFadyen, A. 1953. Notes on Methods forthe Extraction of Small Soil Arthropods. Ecology 22: 65-77.

Macuab, James A. 1958. Biotic aspection in the Coast Range Mountains of Northwestern Oregon. Ecological Monograms 28: 21-54.

McGinnes, William J. 1967. Corrleation between Annual Rings of Woody Plants and Range Herbage Production. Journal of Range Management 20: 42-45.

McMinn, R.G. 1960. Water Relations and Forest Distribution in the Douglas fir Region on Vancouver Island. Canadian Department of Agriculture publication 1091, 71 pp.

Merkle, John. 1951. An Analysis of the Plant Communities of Mary's Peak, Western Oregon. Ecology 32: 618-640.

Mueller-Dembois, Dieter. 1965. Intial stages of Secondary Succession in the Coastal Douglas-fir and Western Hemlock Zones. Ecology of Western North America, vol.1 ed. by V.J. Krajina, pp38-41. University of British Columbia Department of Botony.

Oosting, H.J. 1956. The Study of Plant Communities. San Francisco, W.V. Freeman and Company.

Okloci, Laszlo. 1965. The Coastal Western Hemlock Zone on the south-western British Columbia Mainland. Ecology of Western North America, vol.1 ed. by V.J. Krajina, pp18-34. University of British Columbia Department of Botony.

Perchanec, Anna Alice. 1961. Some Aspects of the Ecology of the Bryophytes in the Three Sisters Primitive Area. 187pp., (Unpublished Ph.D. thesis on file at Oregon State University, Corvallis)

Poulton, C.E. 1962 Range types in Atlas of the Pacific Northwest, 3rd edition. Ed. by Richard M. Highsmithjr., pp61-64, Corvallis, Oregon State University Press.

Rothacher,. Jack, Dyrness,C.T, and Fredrikson, Richard L. 1967. Hydrologic and Related Characteristics of three Small Watersheds in the Oregon Cascades. U.S.D.A. Forest Service, Pacific Northwest Forest and Range Experimental Station, 54pp.