VEGETATION ECOLOGY OF *FRAXINUS LATIFOLIA* COMMUNITIES IN WILLIAM L. FINLEY NATIONAL WILDLIFE REFUGE, OREGON

by

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CONTENTS

TABLES

FIGURES

VEGETATION ECOLOGY OF *FRAXINUS LATIFOLIA* COMMUNITIES IN WILLIAM L. FINLEY NATIONAL WILDLIFE REFUGE, OREGON

Abstract. Composition and structure of Oregon ash (*Fraxinus latifolia*) woodlands in the William L. Finley National Wildlife Refuge, Oregon are described. Twenty stands dominated by *Fraxinus latifolia* were sampled with 500 m^2 circular macroplots in which floristic microplot data were collected for plant community synthesis. Plant communities were identified by computer-assisted tabular analysis and hierarchical agglomerative clustering. Community structure was analyzed from tree-diameter frequency distribution.

Two provisional plant communities are identified: *Fraxinus latifolia/Carex obnupta* and *Fraxinus latifolia/Symphoricarpos albus*. The *Carex obnupta* community was characterized by *C. obnupta*, *Eleocharis acicularis* and *Galium trifidum*. Little shrub cover and appreciable bare ground were typical. *Carex* and *Eleocharis* often formed single-species patches within the stands. Overstory tree canopy was closed and most plots contained many small-diameter trees and reproductive stems and few large diameter trees. *Fraxinus* tree size-class distribution approximates an attenuated reverse J-shaped curve.

The *Symphoricarpos albus* community was marked by much shrub cover, principally provided by *S. albus*, *Rubus ursinus* and *Rosa nutkana*. Herb cover also was great in which *Agrostis aequivalvis*, *Galium aparine*, *Geum macrophyllum*, *Montia sibirica*, *Ranunculus unicinatus* and *Stellaria calycantha* were prominent. Overstory tree cover was more open than in the *Carex obnupta* community. Tree diameter age-class distribution was even, and total basal area larger than for the *Carex* community. Although environmental data were not collected, the *Fraxinus/Carex* community was observed on slightly lower "back-water" areas more distant from the water courses while the *Fraxinus/Symphoricarpos* community was found either on stream natural levees or at outer margins of the lower "back-water" areas away from streams.

INTRODUCTION

Plant communities dominated by Fraxinus latifolia in Oregon's Willamette Valley provide an opportunity to conduct a preliminary investigation in vegetation ecology. Vegetation ecology is defined as the study of plant communities, i.e., assemblages of plants occurring together within a common environment (Mueller-Dombois and Ellenberg 1974). Plant communities are best described by the species which distinguish one community from another. Species with the most massive individuals, the most abundance, and species limited to a given community are all important in defining a community. It is through identification of these categories of species that plant communities may be recognized. Accordingly, the objective of this study is to describe Fraxinus latifolia communities in a portion of the Willamette Valley with respect to floristic composition and structure.

Fraxinus latifolia Benth., the Oregon ash, is the only native Fraxinus in the Pacific Northwest. The natural range of Fraxinus latifolia extends from southern coastal British Columbia southward through Puget Sound and Western Oregon to the San Francisco Bay Region, California. Oregon ash is also present along the western slopes of the Sierra Nevada. It is absent from the Olympic Peninsula, but occurs along the Columbia River as far east as The Dalles (Figure 1).

Fraxinus latifolia is most abundant over its range in the Willamette Valley where the tree grows in seasonally flooded habitats as well as along the lower reaches of streams. It also occurs as scattered individuals in moist lowland situations associated with Acer macrophyllum, Populus trichocarpa, Alnus rubra, Quercus garryana, Pseudotsuga menziesii, Abies grandis, and Salix spp. (Harlow et al. 1979). Trees within the relatively pure Willamette Valley stands are ofter slender with compact crowns and limbs

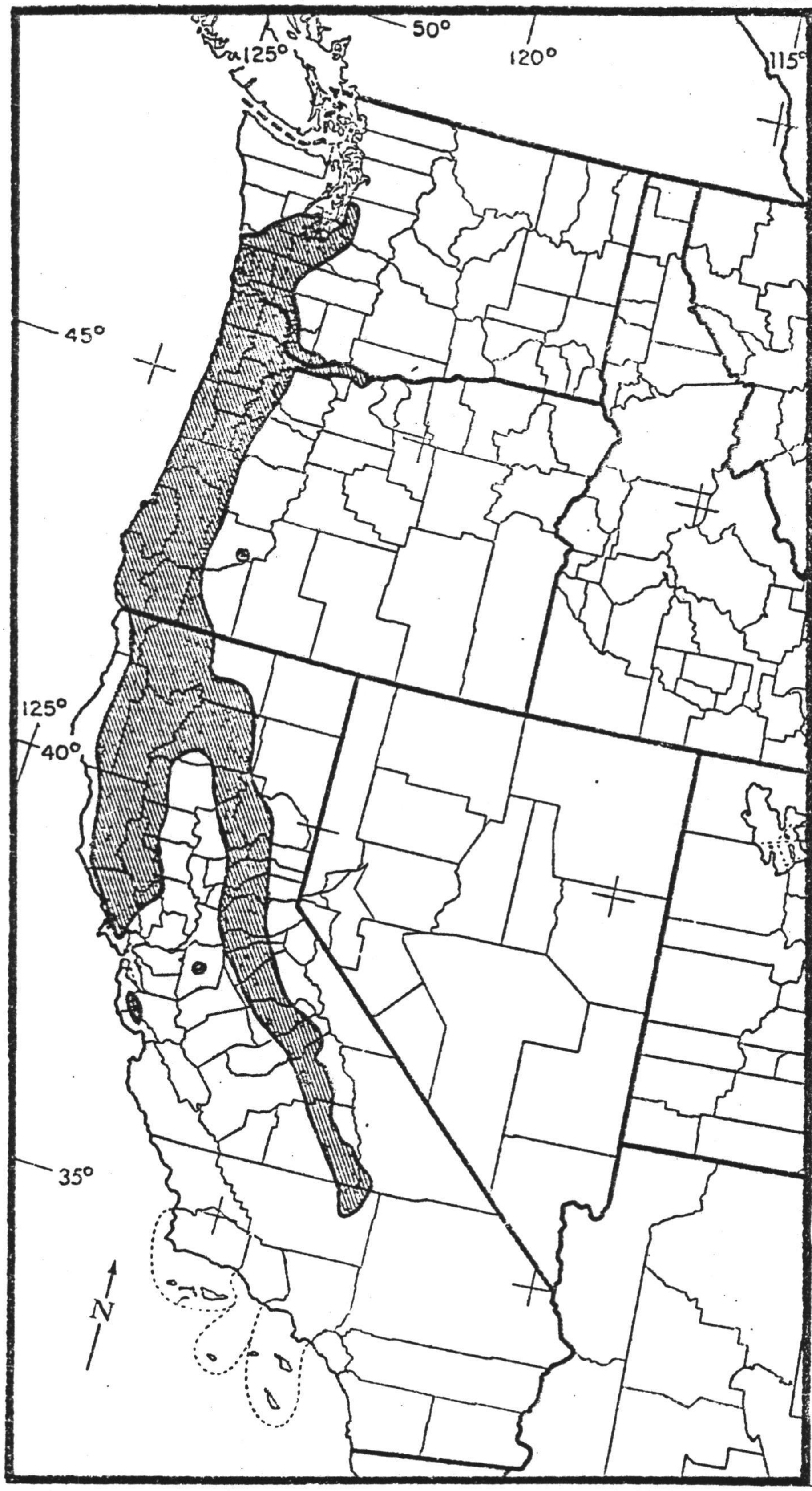

Figure 1. Natural range of Fraxinus latifolia Benth. from Little (1971).

draped with lichens. The understory of these Fraxinus stands varies from a dense cover of shrubs and herbaceous species to a nearly denuded area with scattered tree litter.

A member of the Oleaceae family, Fraxinus latifolia is a medium-sized tree ranging in height from 9 to 30 meters (Jepson 1939). The root system is moderately shallow but very fibrous and wide-spreading, providing unusually good wind resistance (Harlow et al. 1979). Except for the very early seedling stage, Fraxinus latifolia is intolerant to shade (Harlow et al. 1979). In open stands, the trunk is short and branches wide-spreading, but in closed stands trees have narrow trunks and small, compact crowns (Sudworth 1908). When shaded from one side, limbs on the shaded side are quickly self-pruned. Seedlings can resist moderate shading when soil moisture is abundant. As young trees pass the seedling stage, they require considerably more light for continued growth (Harlow et al. 1979). Fraxinus latifolia reproduces both by germination of samaras and by vigorous vegetative sprouting from tree bases (Collinwood and Brush 1978).

Due to the scarcity of hardwood in the Pacific Northwest, Fraxinus latifolia has attained minor commercial value. It is used in the construction of boxes, tool handles, cooperage, sports equipment, and, to a limited extent, for furniture and interior building trim (Collinwood and Brush 1978). In earlier days, the relatively strong hardwood of Fraxinus latifolia made excellent barrels, butter tubs, and wagon parts. Presently, Fraxinus is not abundant in commercial sizes and is therefore not managed for timber production. However, as a firewood, Fraxinus is a preferred fuel. The high heat value and the ease by which it splits has made fuel the most common contemporary use of Oregon ash (Collinwood and Brush 1978).

STUDY AREA

The William L. Finley National Wildlife Refuge contains large, relatively undisturbed stands of *Fraxinus latifolia* (Figure 2). The close proximity to Corvallis and accessibility of the *Fraxinus* stands makes the William L. Finley Refuge an ideal area for this study. The refuge is located in the southwestern portion of the Willamette Valley, approximately 16 km south of Corvallis. Its environment is typical of much of the Willamette Valley, characterized by broad alluvial flats with scattered low hills. Elevations range from 170 m at the top of Mill Hill to 77 m along the flood plain surrounding Muddy Creek (Franklin 1972).

Muddy Creek is a sluggish, valley-bottom stream meandering through the center of the wildlife refuge. Also located within the refuge are several natural and artificial wetland habitats. The wetlands associated with Muddy Creek and its tributaries provide ideal habitat for growth of ash thickets.

The William L. Finley National Wildlife Refuge lies directly within the rainshadow of the Coast Range. As a result, the area is relatively warm and dry when compared to most of western Oregon. The winter season is mild and rainy with January temperatures averaging about 4.9° C and annual precipitation averages 957 mm. Summer precipitation is about 49mm (Franklin 1972).

The soils supporting the *Fraxinus* forests in the refuge are in the Waldo-Bashaw association made of poorly drained silty clay loams and clays which formed in the recent alluvium of Muddy Creek and its tributaries (Knezevich 1975). In this association, two soil series, the Waldo silty clay loam and the Bashaw silty clay loam are typically found under the the ash forests.

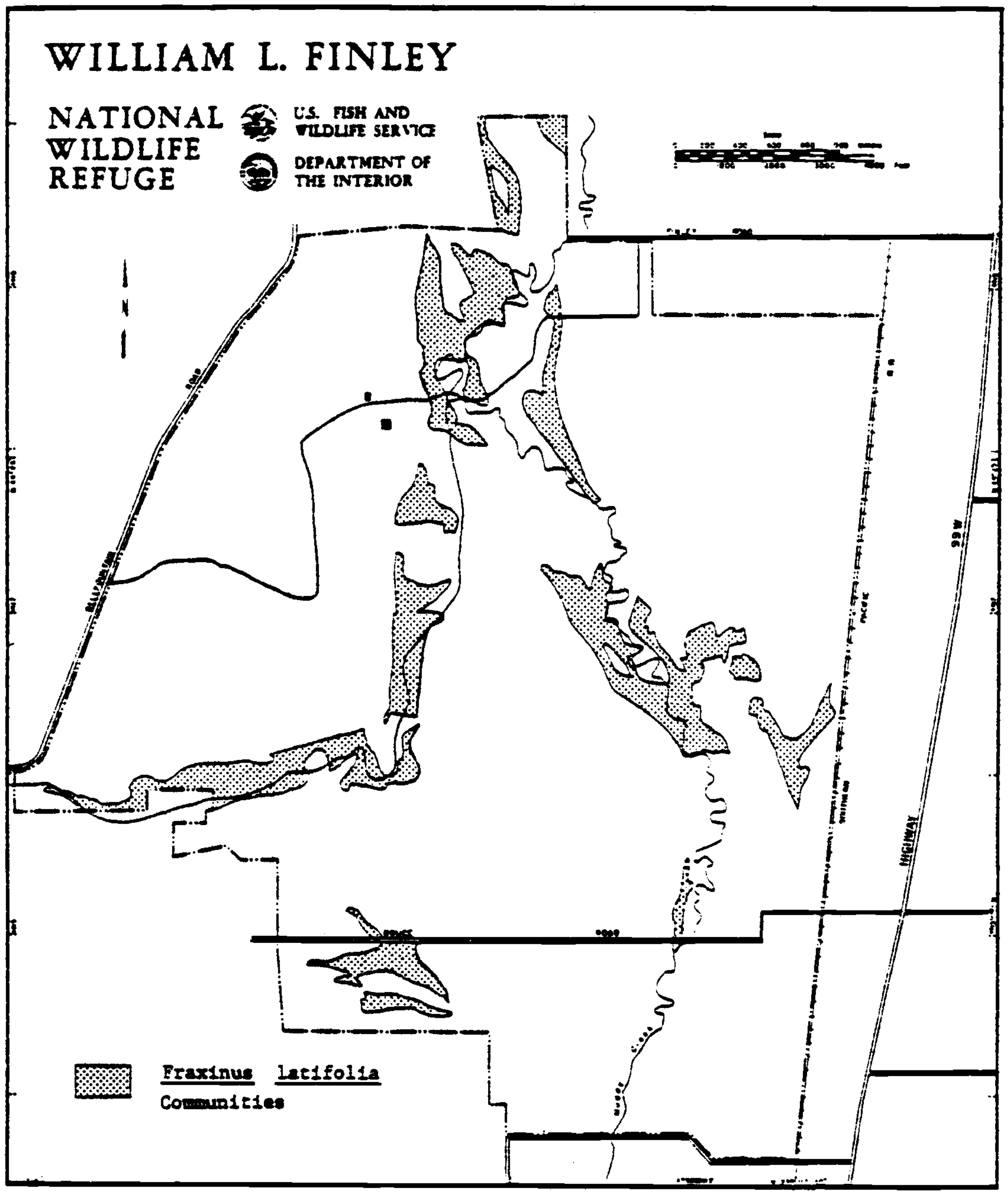

Figure 2. Fraxinus latifolia forest in William L. Finley National Wildlife Refuge.

The Waldo silty clay loam makes up the smaller percentage of the two soils. In a representative profile, the surface layer is black silty clay loam and silty clay about 30 cm thick. The subsoil is dark-gray and gray clay extending to a depth of about 155 cm (Knezevich 1975). This soil is more typically found along the streams and drainageways of the foothills.

The majority of soils associated with Fraxinus are Bashaw silty clay loam. This soil has a black, heavy, silty clay loam surface layer which reaches to depths of between 25 and 45 cm. The underlying layers are black, very dark gray, and dark gray with a layer of silty clay above the clay. When wet, this soil becomes very sticky and plastic. Upon drying, it cracks and becomes very hard (Knezevich 1975).

Both of these soils drain poorly and are subject to frequent flooding. However, their silty clay loam surface horizon allows a somewhat better response to surface and subsurface drainage where outlets are available (Knezevich 1975).

All but one sample plot was located at William L. Finley National Wildlife Refuge. Plot No. 5 was taken in The Nature Conservancy Cogswell-Foster Preserve, 5 km southwest of Halsey, Linn County in an area immediately west of Little Muddy Creek. In William L. Finley National Wildlife Refuge, Plot Nos. 15 and 12 were taken in the Willamette Floodplain Research Natural Area east of Muddy Creek.

METHODS

Field Methods

A reconnaissance survey was conducted in ash stands along Muddy Creek and its tributaries prior to selection of stands and collection of quantitative data from plots. The primary objectives of this reconnaissance were to observe the variation in plant associations within these communities and variation in habitat. The reconnaissance led to the recognition of four hypothetical plant communities dominated by *Fraxinus latifolia*: Provisional Shrub Community, Provisional Herbaceous Community, Provisional Sedge Community, and Provisional Bare Ground Community.

The secondary reconnaissance objective was to identify potential sample sites representative of the *Fraxinus* communities within the refuge. A *Fraxinus* stand had to fulfill two requirements before it was deemed suitable for a sample site: it had to be at least 100 m wide to provide adequate area for a 500 m^2 sample plot permitting a buffer zone between the plot and any disturbed areas or adjacent communities, and the stand had to be relatively homogeneous over an area large enough to cover both the sample plot and the buffer zone.

After all suitable *Fraxinus* stands were identified and marked on the USGS Greenberry 1967 7½' topographic map, approximately twenty areas were arbitrarily chosen to represent possible general locations of sample plots. Each of these sampling areas was located in the field and a sample plot randomly selected. Random plot selection was accomplished after locating a general position in the more or less homogeneous stand. A quick glance at the second hand of a wrist watch provided an unbiased compass direction to follow in choosing a plot location. A number less than 25 was chosen from a random numbers table giving a distance to be paced along the above compass direction. This provided the unbiased center point for the sample plot.

Circular plots 500 m^2 were used to collect structural and floristic data (Figure 3). The circular plot was modeled after a design from the "Vegetation Survey Manual" (Hawk et al. 1979). The plot (macroplot) had a radius of 12.6 meters. Two transects were established along cardinal directions in each macroplot. Twelve, 1 m^2 square microplots were placed along these transects, three along the four compass directions at intervals from the centerpoint of four, seven, and ten meters, respectively.

Canopy cover for each species in the shrub and herbaceous layer was recorded in each microplot. Percent bare ground, forest litter, moss, and number of seedlings were also recorded. Data were recorded in six cover classes (Table 1).

Table 1. Cover class, percent cover, and midpoint cover values after Daubenmire (1957).

Cover Class	Range of Cover (%)	Class Midpoint (%)
0	0	0
1	0.1-5	2.5
2	5-25	15.0
3	25-50	37.5
4	50-75	62.5
5	75-95	85.0
6	95-100	97.5

Midpoint of cover classes were used to calculate the average percent cover per macroplot for each of the taxa encountered (Daubenmire 1959). In addition, a list was made of other species occurring within the boundaries of the macroplot.

Overstory trees were sampled following methods taken from Mueller-Dombois and Ellenberg (1974). All trees greater than 5 cm DBH (Diameter at Breast Height) were measured at 127 cm in each macroplot. Dead trees

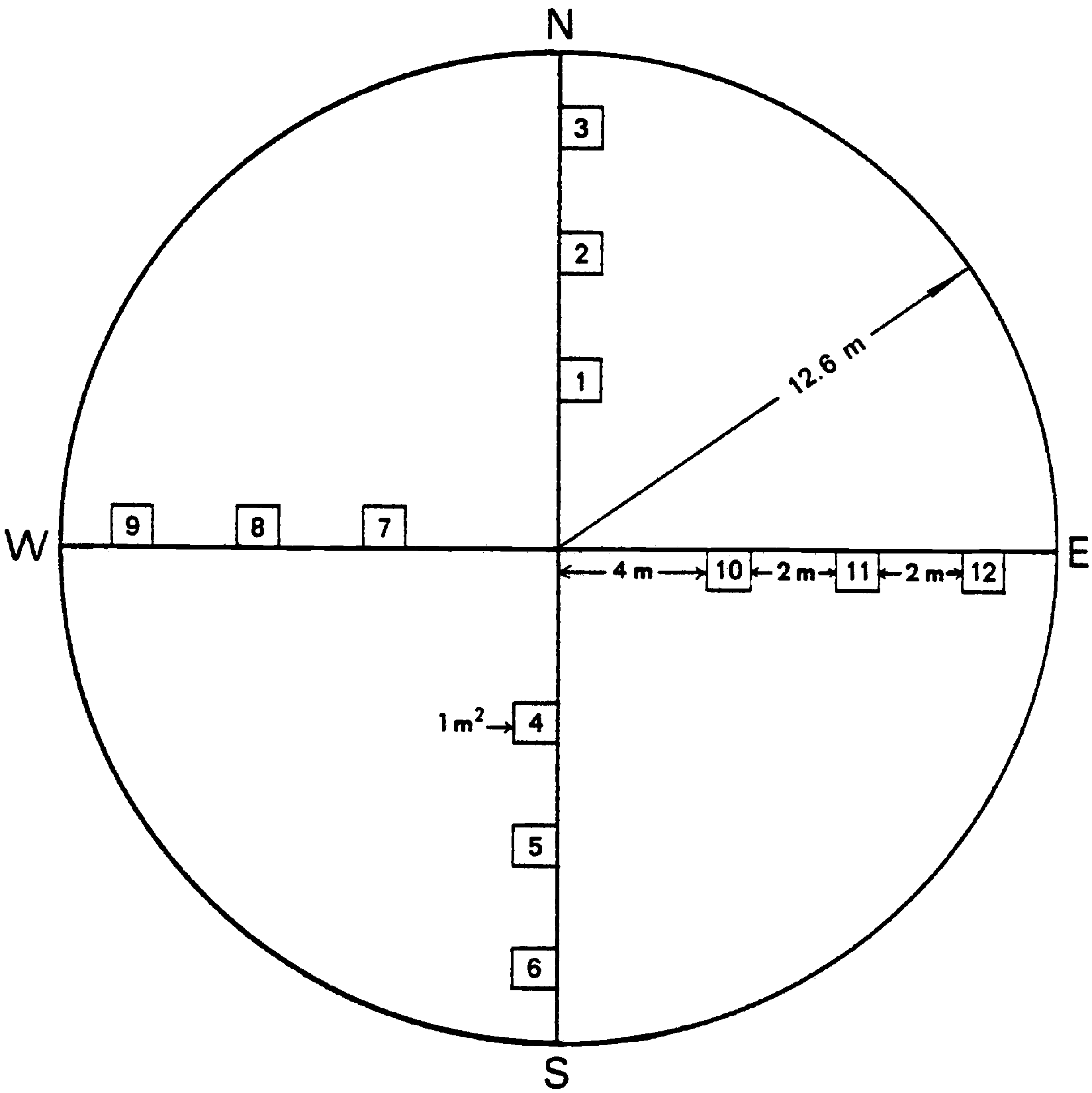

Figure 3. Arrangement of numbered microplots within in circular plot.

were tallied separately. Two to four trees within each macroplot were also selected for increment cores and age determination in the laboratory.

Analytical Methods

The average percent cover for each species within a macroplot was transformed to an octave scale consisting of values from 1-9 (Table 2).

Table 2. Conversion from percent cover midpoint values to octave scale values after Gauch (1982).

Percent Cover Midpoint Value Range	Octave Value
0	0
0 - <0.5	1
0.5 - <1	2
1 - <2	3
2 - <4	4
4 - <8	5
8 - <16	6
16 - <32	7
32 - <64	8
64 - <100	9

This transformation weights species in a balanced fashion for entry into a variety of multivariate programs and approximates a geometric transformation (Gauch 1982).

The basal area for each tree was determined and the sum of the basal areas for all trees in a macroplot compiled. Tree diameters were converted to a diameter class (Table 3) and histograms were constructed of frequency of each diameter class for each macroplot facilitating structural analysis (Whittaker 1980, Juday 1976).

Table 3. Diameter classes

Diameter Class	Diameter Range (cm)
0[a]	< 5
1	5 - 9
2	10 - 14
3	15 - 19
4	20 - 24
5	25 - 29
6	30 - 34
7	35 - 39
8	40 - 44
9	45 - 50
10	> 50

[a]Trees less than 2 m high and less than 5 cm DBH were considered reproduction.

Two separate multivariate computer programs, TABORD and CLUSTER, were used to analyze vegetative data with respect to community composition. The program, TABORD, compiled a phytosociological table by clustering like samples according to a chosen similarity index based on species similarity. The index was:

$$S_{x,y} = \frac{\sum x_i y_i}{\sum x_i^2 + \sum y_i^2 - \sum x_i y_i} \qquad (i = 1, \ldots, n)$$

where x_i and y_i are the scores of species i in samples x and y and n is the number of species. Clusters are displayed vertically in an output table (van der Maarel, et al. 1978). The TABORD program permits the user to set the 'frequency limit' for species entering the analysis, the 'fusion level' at which clusters are formed and the 'threshold value' by which samples may be removed from clusters. Various values of these parameters were experimented with.

The CLUSTER program, a hierarchical agglomerative classification, groups sets of entities on the basis of (dis)similarity. CLUSTER provides for two different similarity coefficients to compare entities and a variety of fusion strategies (Keniston 1978, Boesch 1977). Each clustering operation is summarized as a dendrogram. The dendrogram for this study was derived by employing a normal (Q-mode) classification, a Bray-Curtis dissimilarity measure, and a group average fusion strategy (Boesch 1979). The Bray-Curtis dissimilarity coefficient is:

$$D_{j,k} = \frac{\sum_{i=1}^{n} \left| X_{ij} - X_{ik} \right|}{\sum_{i=1}^{n} (X_{ij} + X_{ik})}$$

n = number of attributes
X_{ij} = value for attribute i of entity j

and is a widely used quantitative measure in ecological studies. The Bray-Curtis dissimilarity was chosen for this dendrogram because it demonstrates a bias in favor of abundant species (Boesch 1977).

The fusion strategy defines the agglomerative operation by which the CLUSTER program arranges entities into clusters and these clusters into groups, which in turn will be arranged into larger clusters until all entities belong to a single cluster. The group average fusion strategy clusters groups based on the mean of all dissimilarity values between clusters and produces moderately sharp clusters with relatively little distortion in the resemblance relationship (Boesch 1977, Keniston 1978).

RESULTS AND DISCUSSION

Fraxinus latifolia plant communities are described based on two complimentary analyses followed by an anlysis of stand structure. Floristic composition of the Finley *Fraxinus* stands is given in Figures 4, 5, and Appendices 1 and 2.

Community Analysis

Tabular Analysis

Two of several TABORD runs are presented. Both are interpreted with respect to habitat conditions and vegetation structure. TABORD control options used for these two runs are given in Table 4.

Table 4. Control options chosen for TABORD runs A and B.

Option	TABORD Run A	TABORD Run B
Frequency Limit (%)	65	60
Fusion Level (%)	60	60
Threshold Value (%)	45	45

TABORD run A produces three clusters labelled clusters 1, 2, and 3 (Figure 4 and Table 5). Cluster 1, represented by 7 samples, is identified by strong dominance of *Carex obnupta*, and high frequency of *Eleocharis acicularis*, and *Galium trifidum*. Average species number is low with a mean of 14.6 species per plot (Table 5), understory species few, and shrub cover sparse. The average similarity of the cluster, a measure of floristic homogeneity, is 61%.

	SPECIES	
	SAMPLE NUMBERS:	00011120011110000111
		45934707801591235582
	CLUSTERCODE:	00000000000000000000
		11111112222223333330
1	FRAXINUS LATIFOLIA	99999999999999999999
18	CAREX DEWEYANA	4--33356-8557-13-376
21	CAREX OBNUPTA	77-986858-886-----51
26	ELEOCHARIS ACICULARIS	-714-51-161-4--1--44
31	GALIUM TRIFIDUM	24-32224651341----37
10	ROSA NUTKANA	---4--4864-314--83--
13	SPIRAEA DOUGLASII	-3----35433-7-----3-
27	ELYMUS GLAUCUS	---8-31-15-31-4---1-
28	EPILOBIUM WATSONII OCCIDE	-----3--34-13-5-----
35	HYPERICUM ANAGALLOIDES	--1----1564---------
40	OENANTHE SARMENTOSA	----1--8-795-----4--
42	PHALARIS ARUNDINACEA	---------1544--3--4-
48	RUMEX CONGLOMERATUS	---21--1344-------1-
51	STACHYS COOLEYAE	------1-6446--------
56	VERONICA SCUTELLATA	14-----164-531-----3
11	RUBUS URSINUS	3--11---83-88876157-
33	GEUM MACROPHYLLUM	------3-56-55-1-1433
43	POLYPODIUM GLYCYRRHIZA	----1--13--5114--11-
47	RANUNCULUS UNCINATUS	2--4--42356231555246
50	STELLARIA CALYCANTHA	1---3-14653651411-4-
14	SYMPHORICARPUS ALBUS	1-1-----1--566-69993
16	AGROSTIS AEQUIVALVIS	-------1-1-4--356-57
19	CAMASSIA LEICHTLINII	-5-------1-1-411--14
30	GALIUM APARINE	-------1---4-135664-
44	POLYSTICHUM MUNITUM	---------6-5--6-361-
52	STELLARIA MEDIA	3-----------14413---
54	TELLIMA GRANDIFLORA	3------3-3---6-5436-
58	VIOLA GLABELLA	-111---1------------
57	VICIA AMERICANA	-------3---4--------
55	TRISETUM CANESCENS	--------5--31--21---
53	TARAXACUM OFFICINALE	---1-1---3-3-------1
49	SANICULA CRASSICAULIS	4-------------1-----
46	RANUNCULUS OCCIDENTALIS	---------1-----1----
45	RANUNCULUS ALISMAEFOLIUS	-4--------1---------
41	PERIDERIDIA GAIRDNERI	--------13---6---457
39	MYOSOTIS LAXA	-32-----7-----------
38	MONTIA SIBIRICA	---12---45-5--888--4
37	MENTHA ARVENSIS	---3---4-5----------
36	JUNCUS BUFONIUS	--1---1------3------
34	HOLCUS LANATUS	--------1---------34
32	GALIUM TRIFLORUM	-----------531----4-
29	FESTUCA ARUNDINACEAE	----------4---------
25	CAREX UNILATERALIS	551---3-7---675---4-
24	CAREX TUMULICOLA	-------------5------
23	CAREX STIPATA	----------3-3-------
22	CARDAMINE OLIGOSPERMA	--------1-----1-----
20	CAREX LEPORINA	---55------4------18
17	ATHYRIUM FILIX-FEMINA	---------------3----
15	VIBURNUM ELLIPTICUM	-------------5------
12	SORBUS SCOPULINA	-------------5---5-4
9	RHUS DIVERSILOBA	------2----3---3-51-
8	RIBES LACUSTRE	---------------3----
7	PHYSOCARPUS CAPITATUS	-------------4------
6	LONICERA INVOLUCRATA	---------5---7------
5	CRATAEGUS DOUGLASII SUKSD	--24-111---------651
4	AMELANCHIER ALNIFOLIA	6--------5----1--55-
3	RHAMNUS PURSHIANA	---1---3-1-3-41-----
2	QUERCUS GARRYANA	-------------7--67--

Figure 4. TABORD run A.

Table 5. Summary of cluster characteristics from TABORD run A.

	Cluster Number 1	2	3
Average similarity	.6095	.5479	.5471
Average number of species	14.6	24.7	20
Number of samples	7	6	6

Cluster 3 assembles six plots and is characterized by species typically found on drier sites. Dominant species are Symphoricarpos albus, Rubus ursinus, Ranunculus uncinatus, Galium aparine, Agrostis aequivalvis, Tellima grandiflora, and Quercus garryana. Montia sibirica is occasionally an important species. Average species number, 20, is higher than in Cluster 1 (Table 5) and the average similarity is 54.7%.

Cluster 2 appears to be intermediate between Clusters 1 and 3. Several prominent species in Cluster 2 are also important in Cluster 1 and 3. Carex obnupta, Eleocharis acicularis, and Galium trifidum are shared by Clusters 1 and 2. Clusters 2 and 3 both have Rubus ursinus, Geum macrophyllum, Ranunculus uncinatus, and Stellaria calycantha. The differentiation between Clusters 1 and 2 can be attributed to a number of species, such as Rosa nutkana, Spiraea douglasii, Oenanthe sarmentosa, Stachys cooleyae, and Veronica scutellata which identify Cluster 2. Mean species number of 24.7 is high and the average similarity is 54.8% (Table 5). Plot 12 was placed by TABORD into the residual group and was not classified. The sequence of Clusters 1, 2, and 3 was tentatively interpreted as a decreasing moisture gradient.

TABORD run B separated two clusters labled 1 and 2 (Figure 5 and Table 6). Cluster 1 contains 9 samples, each with a relatively sparse understory composition. Representative species are Carex obnupta, Eleo-

```
                SAMPLE NUMBERS:  0000111120000000111111
                                 467913-7012358025639

                CLUSTERCODE:     0000000000000000000
                                 1111111112222222222

   SPECIES
 21 CAREX OBNUPTA                778-43364----3-1-356
 26 ELEOCHARIS ACICULARIS        -7-114-51--1-15---44
  1 FRAXINUS LATIFOLIA           9999999999999999999
 18 CAREX DEWEYANA               4-6-53335-13--863577
 31 GALIUM TRIFIDUM              244-132221---657-334
 10 ROSA NUTKANA                 --3--4--44--86--33-1
 11 RUBUS URSINUS                3----11--876183-5378
 14 SYMPHORICARPUS ALBUS         1--1-----8-691-39596
 16 AGROSTIS AEQUIVALVIS         --1-------356-17--5-
 19 CAMASSIA LEICHTLINII         -5-------411--1--11-
 30 GALIUM APARINE               --1------1356------
 33 GEUM MACROPHYLLUM            --------3-1-15634535
 38 MONTIA SIBIRICA              -----12---835-54-5--
 43 POLYPODIUM GLYCYRRHIZA       --1---1--14--3--1511
 47 RANUNCULUS UNCINATUS         2-2-64--415553562243
 50 STELLARIA CALYCANTHA         1-4-3-3-1141165--545
 58 VIOLA GLABELLA               -111-1--------------
 57 VICIA AMERICANA              --3--------------4--
 56 VERONICA SCUTELLATA          141-------1---543-5-3
 55 TRISETUM CANESCENS           -----------215---3-1
 54 TELLIMA GRANDIFLORA          3-3------5-54-3-3-5-
 53 TARAXACUM OFFICINALE         -----1-1------31-3--
 52 STELLARIA MEDIA              3--------4413----1-4
 51 STACHYS COOLEYAE             ----4---1----54--5--
 49 SANICULA CRASSICAULIS        4----------1--------
 48 RUMEX CONGLOMERATUS          --1-421------34---1-
 46 RANUNCULUS OCCIDENTALIS      -----------1--1-----
 45 RANUNCULUS ALISMAEFOLIUS     -4--1---------------
 44 POLYSTICHUM MUNITUM          ----------5-3-5-531-
 42 PHALARIS ARUNDINACEA         ----5------3--1--444
 41 PERIDERIDIA GAIRDNERI        ----------5---1374-5-
 40 OENANTHE SARMENTOSA          --3-9-1--------7--5--
 39 MYOSOTIS LAXA                -3-2-----------7-----
 37 MENTHA ARVENSIS              --4--3---------5-----
 36 JUNCUS BUFONIUS              ---1----1-----------3
 35 HYPERICUM ANAGALLOIDES       --114---------56-----
 34 HOLCUS LANATUS               --------------1-4--3-
 32 GALIUM TRIFLORUM             ----------1-------543
 29 FESTUCA ARUNDINACEAE         ---------------4-----
 28 EPILOBIUM WATSONII OCCIDE    -------3--5--34--1-3
 27 ELYMUS GLAUCUS               -----3-31-4--15--311
 25 CAREX UNILATERALIS           56-1----375--7-----46
 24 CAREX TUMULICOLA             --------------------5
 23 CAREX STIPATA                ---------------3---3--
 22 CARDAMINE OLIGOSPERMA        -----------1--1------
 20 CAREX LEPORINA               ----465--------3--1-
 17 ATHYRIUM FILIX-FEMINA        ----------3---------
 15 VIBURNUM ELLIPTICUM          ----------5---------
 13 SPIRAEA DOUGLASII            -35-3---3-----43---37
 12 SORBUS SCOPULINA             ----------5------45---
  9 RHUS DIVERSILOBA             --------2--3-----531-
  8 RIBES LACUSTRE               -----------3--------
  7 PHYSOCARPUS CAPITATUS        --------------------4
  6 LONICERA INVOLUCRATA         ---------------5-----7
  5 CRATAEGUS DOUGLASII SUKSD    --12-4-11-------15-8-
  4 AMELANCHIER ALNIFOLIA        6----------1---5-5-5-
  3 RHAMNUS PURSHIANA            --3--1---41---1--3--
  2 QUERCUS GARRYANA             ---------7--6----7---
```

Figure 5. TABORD run B.

charis acicularis, and Rumex conglomeratus. Other understory species are few and shrub cover sparse. Mean species number is 15.5 and average similarity of Cluster 1 is 66.1%.

Table 6. Summary of cluster characteristics for TABORD Run B.

	Cluster Number	
	1	2
Average similarity	.6610	.5680
Average number of species	15.5	22.7
Number of samples	9	11

It appears that this cluster is similar to Cluster 1 in TABORD Run A but shows higher homogeneity.

The 11 remaining plots have been placed into Cluster 2. This cluster has a high mean species number (22.7) and is dominated by shrubs. Dominant species are Rubus ursinus, Symphoricarpos albus, Montia sibirica, Geum macrophyllum, Tellima grandiflora, Amelanchier alnifolia, and Quercus garryana. The average similarity of this cluster is 56.8%. This cluster compares closely to Cluster 2 in TABORD Run A but has a slightly higher homogeneity.

Cluster Analysis

Hierarchical agglomerative clustering with CLUSTER identified two clusters, A and B (Figure 6). Ten plots (15, 18, 1, 3, 5, 2, 8, 19, 16, and 10) in Cluster A were fused at 60% dissimilarity. Plots in Cluster A exhibited considerable heterogeneity suggested by the relatively high levels of fusion. Cluster B was formed by fusion of 8 plots (7, 11, 20, 13, 14, 17, 4, and 6) at 56% dissimilarity. This cluster showed a higher degree of homogeneity than in Cluster A. Neither plot 12 nor plot 9 were

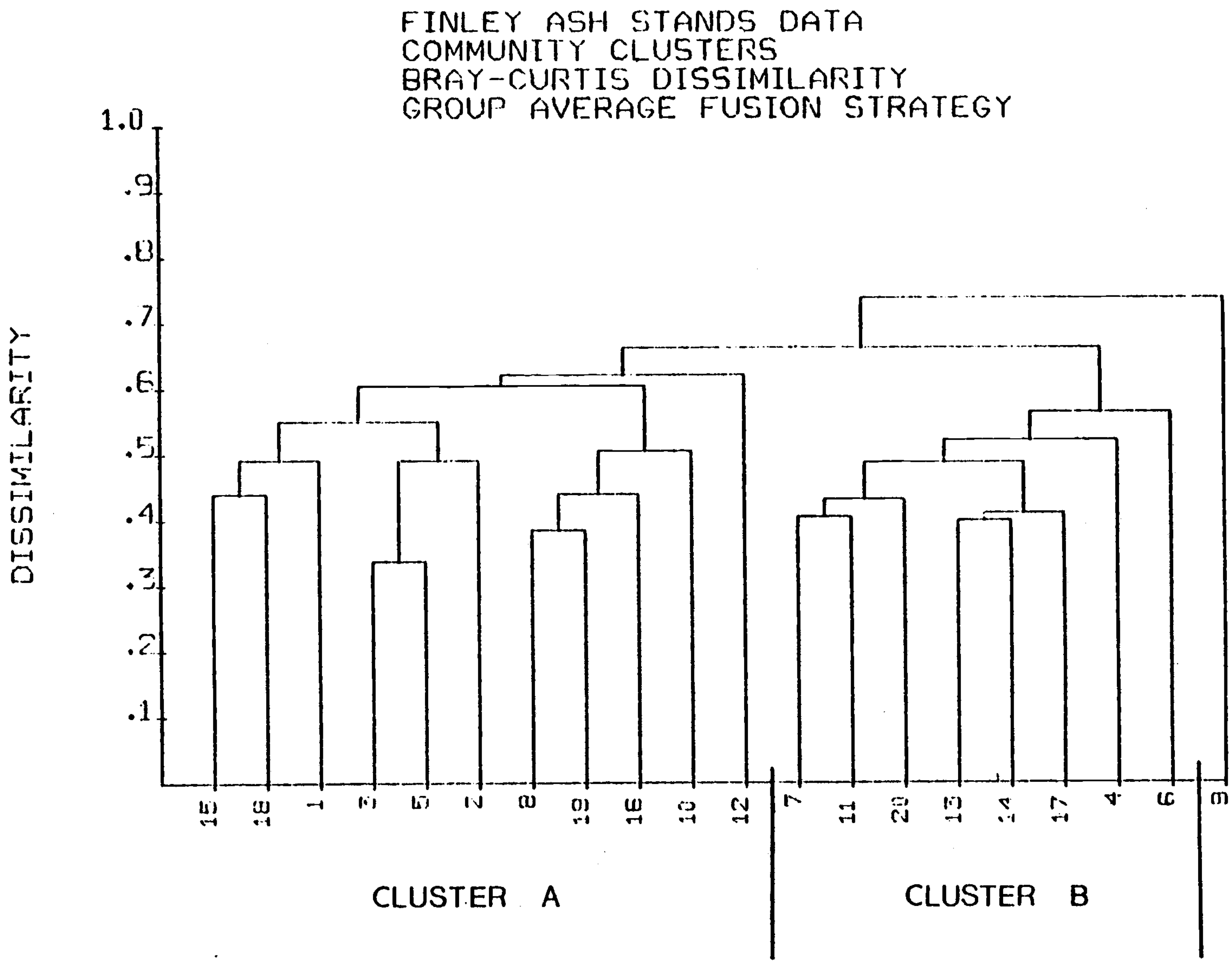

Figure 6. Hierarchical agglomerative clustering of <u>Fraxinus latifolia</u> plots.

fused in the above clusters. Several subclusters can be recognized in this analysis but because of their heterogeneity and limited sampling, no further classification was attempted.

Comparison of TABORD and CLUSTER Analysis

Results of tabular analysis and hierarchical clustering may be compared. Floristic heterogeneity of the sampled Fraxinus stands and the limited extent of sampling makes it difficult to distinguish more than two communities (Figure 5 and 6). Table 7 compared the above two analyses with respect to membership of plots in respective clusters.

Table 7. Comparison of hierarchical and tabular analysis in terms of plot membership in clusters.

Hierarical Cluster Analysis	Tabular Analysis B	
	Cluster 1	Cluster 2
Cluster A	---	1,2,3,5,8,10,15, 16,18,19
Cluster B	4,6,7,11,13, 14,17,20	---
Not clustered	9	12

TABORD Cluster 1 corresponds closely to Cluster B showing higher homogeneity, fewer species, and lower shrub cover than Cluster 2 or A, and having the indicator species Carex obnupta, Eleocharis acicularis, and Galium trifidum. TABORD Cluster 2 corresponds to CLUSTER A and has a greater heterogeneity and higher shrub and herb cover than in Cluster B.

Plant Communities

The twenty macroplots are grouped into two provisional plant communities based on understory composition: the Carex obnupta and the Symphoricarpos albus community. Species constancy, frequency, mean percent cover, and cover range are given in Appendix 1 and 2.

The Carex obnupta community (Appendix 1) is marked by strong dominance of Carex obnupta which commonly grows in patches ranging in size from one to several square meters. The extent of this cover may be over 60% of the macroplot area. This community exhibits high constancy but low cover of Galium trifidum. Eleocharis acicularis is also a frequent species (67%) in the herbaceous layer but exhibited a low cover. Although Eleocharis only had 67% frequency in the microplots, it occurred with 100% frequency in the Carex obnupta community macroplots. Prominence of Carex obnupta, C. deweyana, and Eleocharis acicularis suggests a relatively moist, poorly drained environment occupying "backwaters" away from the creeks. The community usually lacks abundant shrub cover but has a patchy understory with conspicuous areas of bare ground. The forest floor is often blanketed with much Fraxinus litter. Mean cover of bare ground was 22.4% and ranged from 1.3% to 56.3%. The overstory canopy of the Carex community is closed, allowing little light to filter to the understory vegetation. This restricted insolation may be a limiting factor in the survival of young Fraxinus seedlings and saplings.

The Symphoricarpos albus community is rich in shrubs, all with high constancy and cover, including Symphoricarpos albus, Rubus ursinus, and Rosa nutkana (Appendix 2). Symphoricarpos albus often shows over 60% cover (mean percent cover 25.8 and a range 1 - 80.6%) and is 1 m or more high. Although Rubus ursinus was present in almost every sample of the community, it did not reach the cover of Symphoricarpos. Polystichum munitum was present in almost every macroplot although it also did not have extensive cover. This community is also characterized by a heavy understory of perennial herbs including Carex deweyana, Galium trifidum, Agrostis aequivalvis, Galium aparine, Geum macrophyllum, Montia sibirica, Ranunculus uncinatus, Stellaria calycantha, and S. media. Quercus garryana, Tellima grandiflora, and Crataegus douglasii occurred in some plots. Average percent bare ground was 2.5% with a range of .6% to 7.7%.

Fraxinus latifolia trees associated with this community had an average diameter larger than those recorded in the Carex obnupta community. Quercus garryana usually had a diameter greater than 20 cm. The overstory canopy is generally open, possibly permitting dense shrub and herbaceous growth which through competition may inhibit Fraxinus reproduction. The dense shrub cover and composition of herbaceous species suggest that this community occupies a more mesic environment than the Carex obnupta community. The location of this community at the edges of Fraxinus stands and along the natural levees of the creeks support this suggestion.

Structural Analysis

Histograms of tree diameter frequency show different patterns for the Carex obnupta and the Symphoricarpos albus communities. The majority of Carex community plots contains a large number of small diameter trees and many reproductive stems (Figure 7). This diameter-size distribution is shown by an attenuated reverse J-shaped diameter distribution. The exception to this generalization is with plots 7 and 11 which show a much lower number of stems in reproductive classes.

Histograms of the Symphoricarpos albus community tree diameter diameter frequency indicate a trend toward more even size distribution through all size classes, corresponding to low reproduction and larger diameter trees (Figure 8). However, histograms for plots 2 and 3 have more of a reverse J-shaped diameter class pattern than those for other

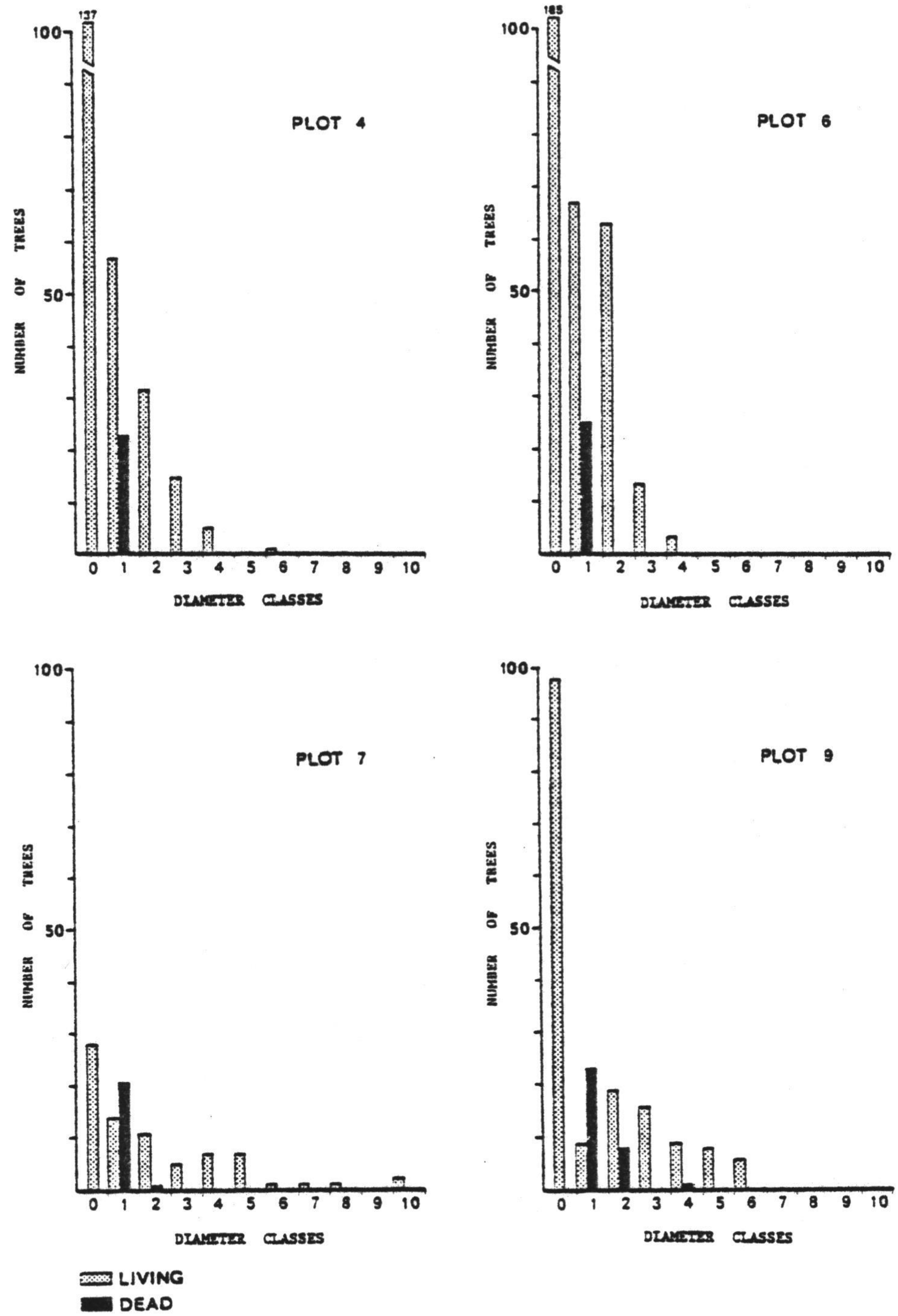

Figure 7a. Diameter class-frequency histograms for the *Carex obnupta* community.

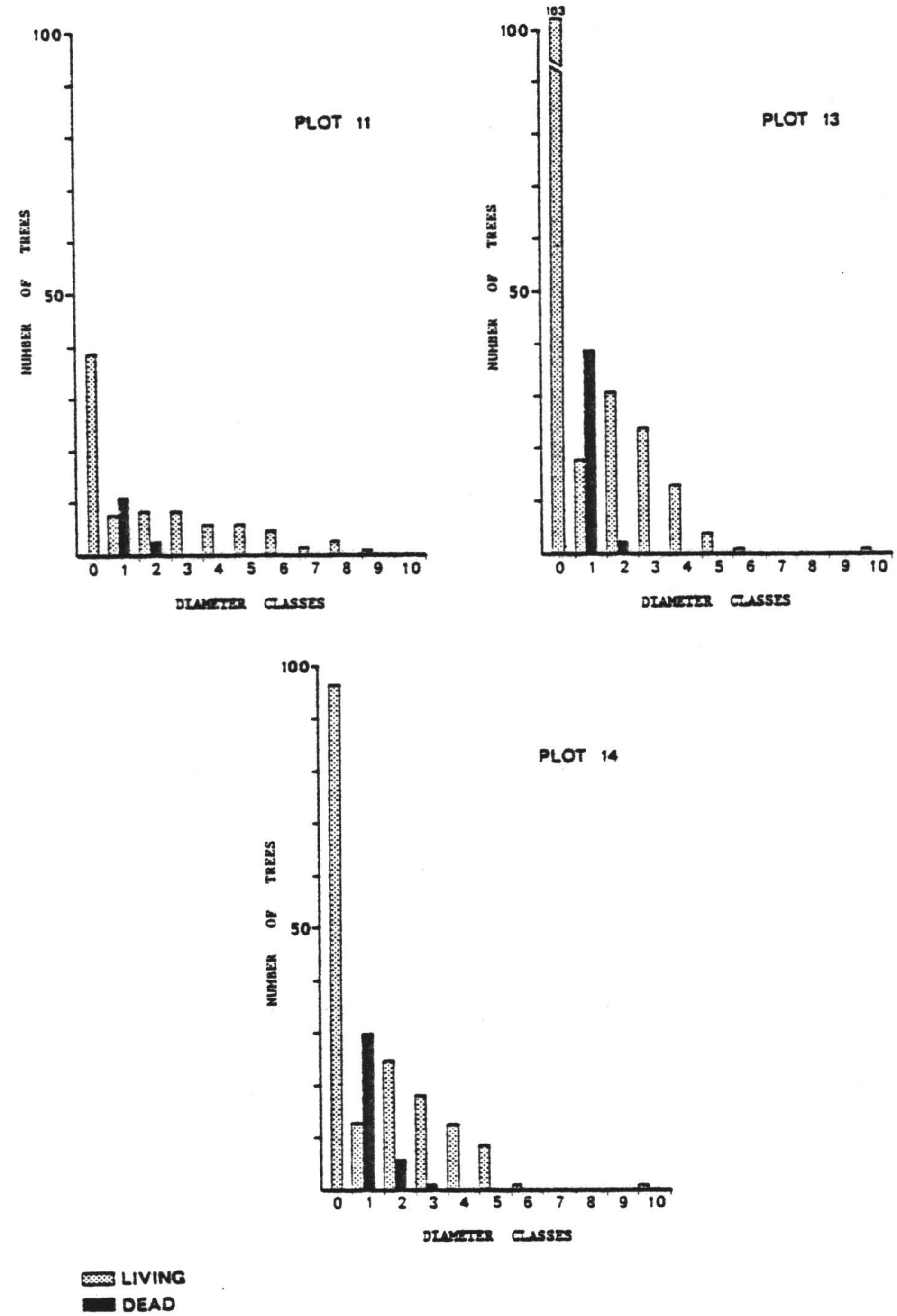

Figure 7b. Diameter class-frequency histograms for the *Carex obnupta* community.

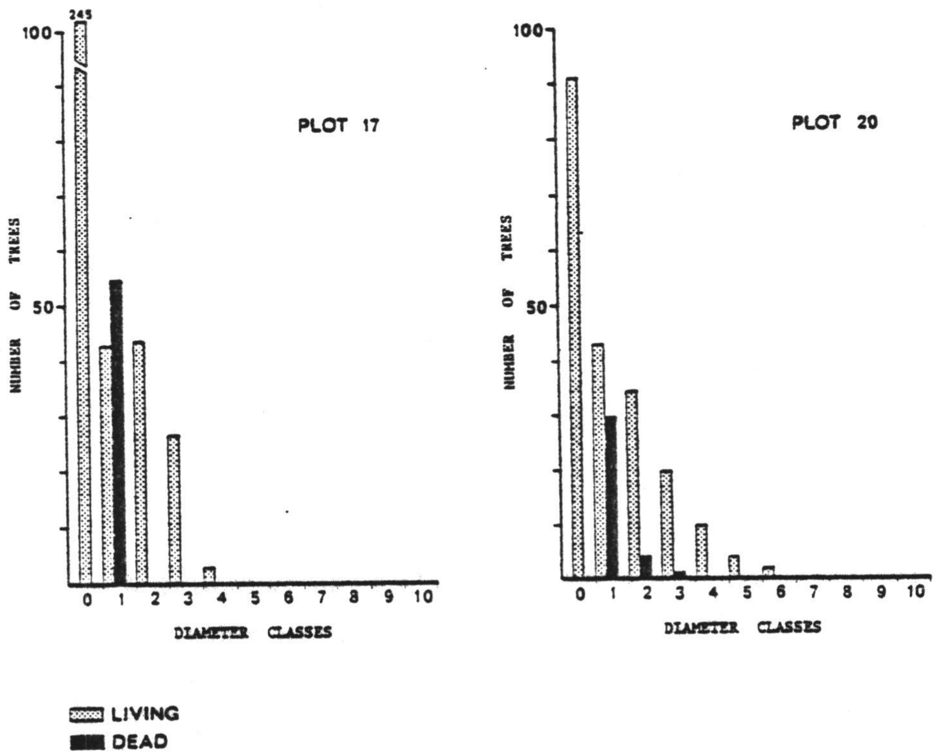

Figure 7c. Diameter class-frequency histograms for the <u>Carex obnupta</u> community.

plots in the Symphoricarpos albus community. Plots 1, 12, and 15 show a slight reverse J-shaped pattern. Table 8 summarizes the above relationship between diameter size distribution pattern and understory vegetation cover.

Table 8. Comparison between diameter class distribution pattern and mean percent understory vegetation cover.

Attenuated Reproductive Classes			Moderate Reproductive Classes			Even Size Distribution		
Plot No.	% cover	Community	Plot No.	% cover	community	Plot No.	% cover	community
2	111.9	Syal	1	170.3	Syal	5	195.4	Syal
3	124.9	Syal	7	125.1	Caob	8	200.6	Syal
4	45.1	Caob	11	147.2	Caob	10	211.1	Syal
6	79.3	Caob	12	154.4	Syal	16	107.4	Syal
9	3.2	Caob	15	148.6	Syal	18	203.4	Syal
13	133.6	Caob				19	185.2	Syal
14	72.5	Caob						
17	20.4	Caob						
20	77.3	Caob						
Mean % cover 74.3			Mean % cover 149.1			Mean % cover 200.5		
Range (%) 3.2 - 133.6			Range (%) 125.1 - 170.3			Range (%) 185.2 - 211.1)		

Plots with the highest number of trees in the reproductive class and with many small diameter trees have the least understory cover. Plots with few trees in reproductive classes and several large diameter trees have more dense understory vegetation. Percentage vegetation cover greater than 100% was due to multiple layers of vegetation.

Table 9 gives tree basal area per macroplot for Carex obnupta and Symphoricarpos albus plant communities. The Carex community with many spindly trees has about half the basal area of the Symphoricarpos community. The latter community has less dense tree growth, although the trees are larger.

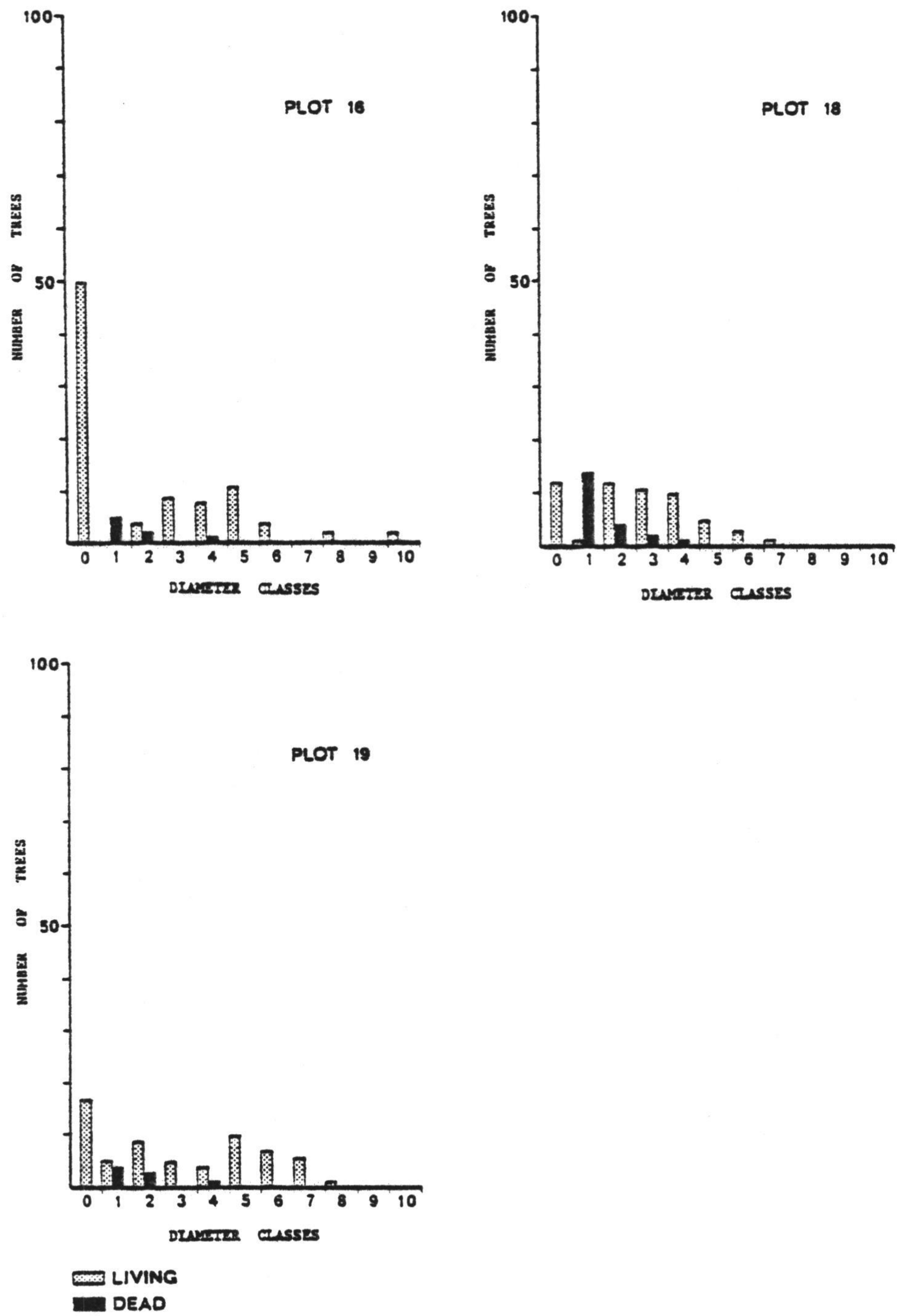

Figure 8a. Size class-frequency histograms for the *Symphoricarpos albus* community.

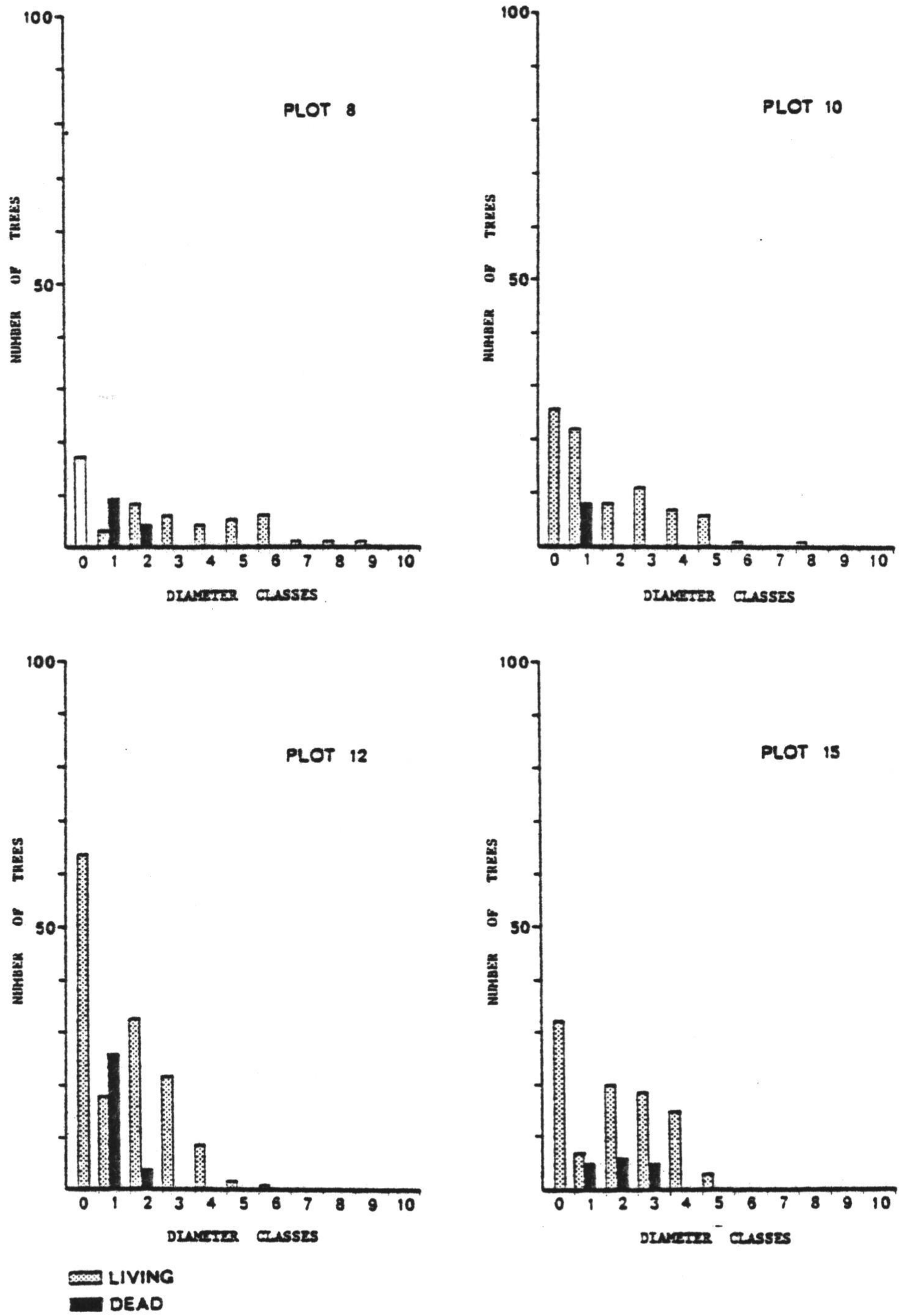

Figure 8b. Size class-frequency histograms for the *Symphoricarpos albus* community.

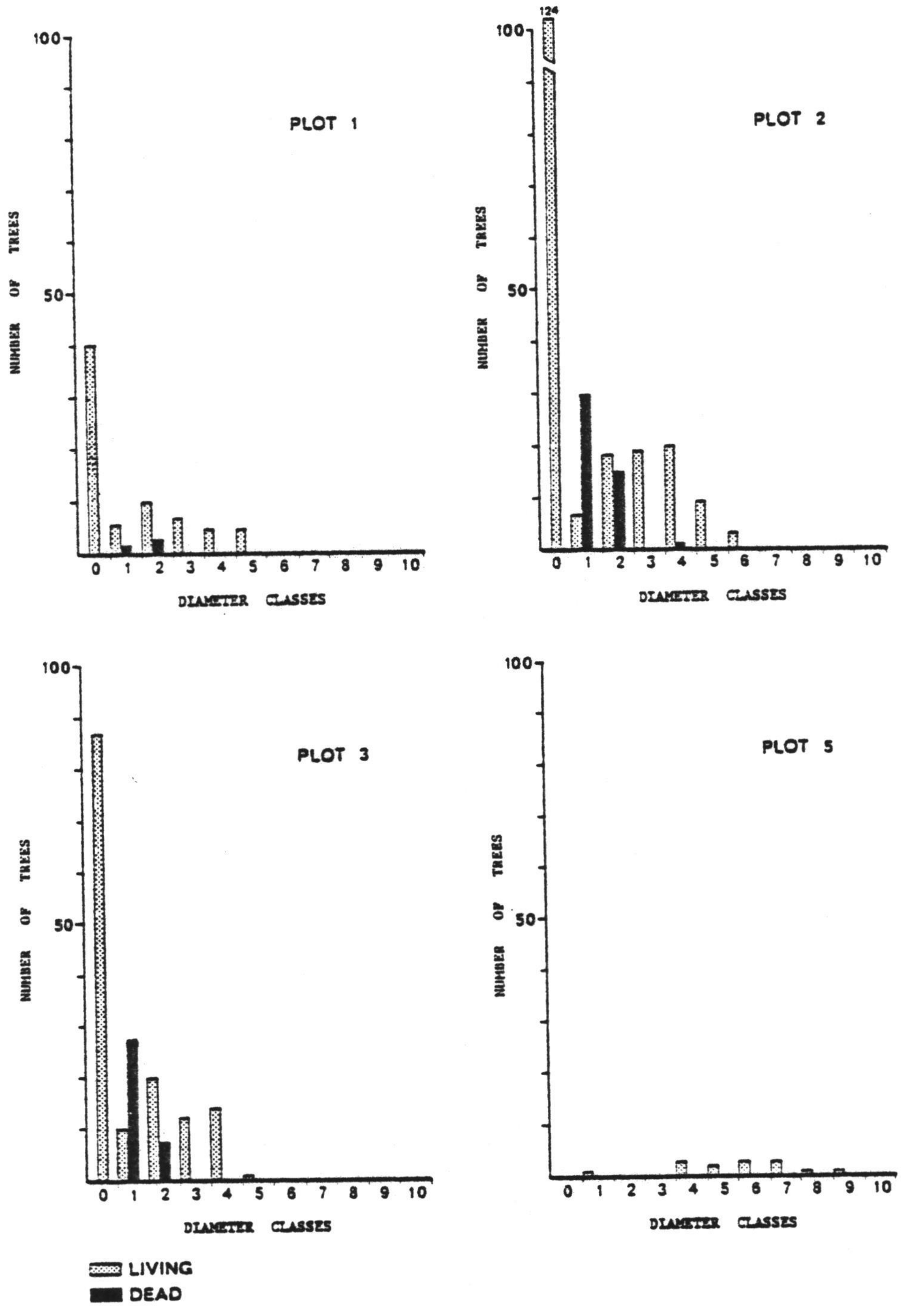

Figure 8c. Size class-frequency histograms for the <u>Symphoricarpus albus</u> community.

Table 9. Mean basal area per tree and basal area per macroplot by plant community membership.

Carex Community			*Symphoricarpos* Community		
Plot No.	Mean basal area per tree (cm^2)	BA/macroplot	Plot No.	Mean basal area per tree (cm^2)	BA/macroplot
4	87	12.4	1	210	8.0
6	83	14.2	2	199	29.3
7	217	15.2	3	151	14.0
9	219	21.7	5	793	11.1
11	319	20.1	8	338	16.2
13	231	30.7	10	262	16.8
14	190	22.2	12	139	16.0
17	92	15.8	15	217	13.9
20	127	18.7	16	504	24.1
			18	296	16.0
			19	431	23.7
Mean basal area = 174 $cm^2/500\ m^2$ = 34.8 m^2/ha			Mean basal area = 322 $cm^2/500\ m^2$ = 64.3 m^2/ha		

Although limited age data were taken in the *Fraxinus* stands, Table 10 summarizes the age distribution data by plant community for the 60 trees cored.

Table 10. Mean age of selected large *Fraxinus* trees in macroplots by plant community.

	Plant Community	
	Carex obnupta	*Symphoricarpos albus*
Mean age[a]	59.3	79.6
N	33	27

[a] Age determined from ring counts of increment cores taken at 1.2 m above ground surface.

Mean age of *Fraxinus* trees in the *Carex obnupta* plant community was 59.3 years compared to 69.2 years in the *Symphoricarpos* community. This suggests that although the *Carex* community has markedly different size structure than the *Symphoricarpos* community, the age of the stands were not greatly different. However, the slight difference in age might also be due to the selection of the largest trees for coring. Analysis of the history of the ash stands with respect to disturbance and fire was beyond the scope of this research.

Comparison with Similar Plant Communities

Previous studies of Fraxinus latifolia have dealt almost exclusively with its taxonomy, description, physiology, and distribution. No studies provide quantitative data on Fraxinus communities. Franklin and Dyrness (1973) in a regional survey mention plant communities in which Fraxinus is the dominant species but these communities can vary widely from very sparse understory vegetation under dense stands of trees to dense shrub and herbaceous cover under a scattered tree overstory.

In a study of Quercus garryana woodlands, Thilenius (1964) described an oak community similar to the Fraxinus latifolia/Symphoricarpos albus community identified in this paper. Thilenius' Quercus garryana/Amelanchier alnifolia-Symphoricarpos albus association was found on gentle slopes and ridge tops in the Willamette Valley, areas which appear much too dry for Fraxinus. However, characteristic understory species in this community are Symphoricarpos albus, Rubus ursinus, Rosa nutkana, and Amelanchier alnifolia. Although Amelanchier was the dominant species in this oak community, it appeared only occasionally in the present study of Fraxinus. Symphoricarpos was a dominant species in both communities. Additionally, Rhus diversiloba was found abundantly in both the Quercus/Amelanchier-Symphoricarpos community and the Fraxinus/Symphoricarpos community although quantitative sampling with microplots in the Fraxinus forest did not indicate this. Rhamnus purshiana was a minor species in both communities. Herbaceous species commonly found in both communities included Polystichum munitum, Galium spp., Tellima grandiflora, Holcus lanatus, and Elymus glaucus. It therefore appears that Thilenius' Quercus/Amelanchier-Symphoricarpos community occurs at the mesic end of a moisture gradient in oak forests in the Willamette Valley while the Fraxinus/Symphoricarpos community described here represents the xeric end of the moisture gradient for ash forests.

SUMMARY

This study was designed as a preliminary investigation of the floristic composition and structure of Fraxinus latifolia woodlands in the William L. Finley National Wildlife Refuge. It is to serve as a framework for future synecological studies of Fraxinus forests and their ecological relationships.

After a reconnaissance survey to observe variations in composition within the Finley Fraxinus forests, quantitative data were collected from twenty, 500 m^2 circular macroplots. Structural analysis examined size-class distribution in the Fraxinus stands. Analysis of floristic data was based on the multivariate programs, TABORD and CLUSTER.

Fraxinus latifolia is the dominant tree in all plots. Based on understory composition, two provisional communities were identified: the Carex obnupta community and the Symphoricarpos albus community. The communities differed in structural characteristics, as well.

The Carex obnupta community also has Eleocharis acicularis and Galium trifidum as important species. The community lacks abundant shrub cover and has conspicuous areas of bare ground. Overstory tree canopy is closed and the majority of plots contain a large number of small-diameter trees, many reproductive stems, and few large diameter trees. This size-class distribution approximates an attenuated reverse J-shaped size class curve.

The Symphoricarpos albus community is rich in shrubs. Besides Symphoricarpos, important shrubs included Rubus ursinus and Rosa nutkana. The community also has a rich understory of herbs including Agrostis aequivalvis, Galium aparine, Geum macrophyllum, Montia sibirica, Ranunculus uncinatus, and Stellaria calycantha. The composition of the shrub and herb cover suggests a more mesic habitat than prevails for the Carex community.

Tree diameter frequency displays a more even size distribution. Total mean basal area for this community is higher than that of the *Carex obnupta* community.

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APPENDICES

APPENDIX 1

Composition Characteristics of the Fraxinus latifolia/Carex obnupta Plant Community.

Species	Microplot Constancy (%)[a] (n=108)	Macroplot Frequency (%)[b] (n=9)	Microplot Cover (%) Mean	Microplot Cover (%) Range	SD
Tree Layer					
Fraxinus latifolia	-	100	-	-	-
Rhamnus purshiana	-	22	-	-	-
Shrub Layer					
Spiraea douglasii	11	44	1.3	0-7.3	2.4
Crataegus douglasii	9	56	.5	0-3.3	1.1
Rosa nutkana	6	33	.8	0-3.1	1.3
Rubus ursinus	3	33	.2	0-1.3	.4
Rhus diversiloba	3	11	.1	0-.6	.2
Symphoricarpos albus	2	22	<.1	0-.2	.1
Amelanchier alnifolia	2	11	.9	0-8.3	2.8
Herb Layer					
Carex obnupta	63	89	35.7	-	-
Galium trifidum	29	89	1.7	0-3.3	1.1
Carex deweyana	25	78	3.8	0-15.6	4.5
Eleocharis acicularis	21	67	3.5	-	-
Ranunculus uncinatus	21	56	1.7	0-8.3	2.7
Oenanthe sarmentosa	19	33	11.2	0-65.8	23.4
Carex unilateralis	18	44	2.6	0-14.6	5.1
Carex leporina	15	33	2.0	0-10.4	3.6
Stellaria calycantha	11	56	.8	0-3.2	1.2
Elymus glaucus	9	33	4.5	0-38.8	12.9
Camassia leichtlinii	8	11	.4	0-4.0	1.3
Rumex conglomeratus	7	44	.4	0-2.7	.9
Veronica scutellata	6	33	.4	0-2.7	.9
Mentha arvensis	6	22	.5	0-2.9	1.0
Viola glabella	5	44	.1	0-.4	.1
Hypericum anagalloides	5	33	.5	0-3.8	1.3

Appendix 1 - Fraxinus latifolia/Carex obnupta plant community cont.

Species	Microplot Constancy (%)[a] (n=108)	Macroplot Frequency (%)[b] (n=9)	Microplot Cover (%) Mean	Microplot Cover (%) Range	SD
Herb Layer cont.					
Montia sibirica	5	22	.1	0-.8	.3
Stachys cooleyae	4	22	.3	0-2.5	.8
Tellima grandiflora	4	22	.3	0-1.4	.6
Stellaria media	4	11	.2	0-1.9	.6
Ranunculus alismaefolius	3	22	.3	0-2.7	.9
Phalaris arundinacea	3	11	1.2	0-10.4	3.5
Geum macrophyllum	3	11	.2	0-1.7	.6
Myosotis laxa	2	22	.2	0-1.4	.5
Juncus bufonius	2	22	<.1	0-.2	.1
Polypodium glychirrhiza	2	22	<.1	0-.2	.1
Taraxacum officinale	2	22	<.1	0-.2	.1
Sanicula crassicaulis	1	11	.3	0-3.1	1.0
Epilobium watsonii	1	11	.1	0-1.3	.4
Vicia americana	1	11	.1	0-1.3	.4
Agrostis aequivalvis	1	11	<.1	0-.2	.1
Galium aparine	1	11	<.1	0-.2	.1

[a]Frequency within 108 Carex obnupta community microplots.

[b]Frequency within 9 Carex obnupta community macroplots.

APPENDIX 2

Composition Characteristics of the Fraxinus latifolia/Symphoricarpos albus Plant Community.

Species	Microplot Constancy (%)[a] (n=132)	Macroplot Frequency (%)[b] (n=11)	Microplot Cover (%) Mean	Microplot Cover (%) Range	SD
Tree Layer					
Fraxinus latifolia	-	100	-	-	-
Quercus garryana	-	27	-	-	-
Rhamnus purshiana	-	36	-	-	-
Shrub Layer					
Rubus ursinus	55	91	22.1	0-58.7	20.8
Symphoricarpos albus	48	100	25.8	0-80.6	32.4
Rosa nutkana	22	91	5.8	0-42.7	12.7
Spiraea douglasii	11	55	2.4	0-20.2	5.0
Crataegus douglasii	11	36	4.2	0-36.5	11.1
Amelanchier alnifolia	8	45	1.3	0-6.9	2.5
Rhus diversiloba	5	55	.7	0-4.6	1.4
Sorbus scopulina	5	36	1.2	0-6.3	2.3
Lonicera involucrata	5	18	2.5	0-20.6	6.3
Ribes lacustre	1	36	.1	0-1.3	-
Physocarpus capitatus	1	9	.3	0-3.5	1.1
Herb Layer					
Montia sibirica	48	73	14.1	0-63.5	21.7
Ranunculus uncinatus	45	100	3.8	.2-12.3	3.6
Galium aparine	39	64	3.6	0-15	4.8
Stellaria calycantha	36	100	3.6	0-11.3	4.3
Carex deweyana	35	73	9.5	0-41.3	13.1
Carex unilateralis	32	45	7.6	0-29.4	10.9
Agrostis aequivalvis	31	91	5	0-22.5	7.4
Galium trifidum	31	64	3.6	0-16.2	5.4
Geum macrophyllum	26	91	3.2	0-16.2	5.4
Tellima grandiflora	25	64	3.6	0-15.8	5.3
Perideridia gairdneri	22	73	3.1	0-16.5	5.2

Appendix 2 - Fraxinus latifolia/Symphoricarpos albus plant community cont.

Species	Microplot Constancy (%)[a] (n=132)	Macroplot Frequency (%)[b] (n=11)	Microplot Cover (%) Mean	Range	SD
Herb Layer cont.					
Polystichum munitum	20	91	3.5	0-12.5	4.7
Carex obnupta	20	55	9.6	0-57.7	18.7
Stellaria media	18	64	.7	0-2.5	1.0
Veronica scutellata	17	55	2.3	0-13.8	4.2
Camassia leichtlinii	15	82	.6	0-3.1	1.1
Elymus glaucus	15	55	1.2	0-7.9	2.4
Eleocharis acicularis	14	55	2.2	0-14.4	4.3
Epilobium watsonii	14	45	1.1	0-4.4	1.6
Stachys cooleyae	14	27	2.8	0-14.4	5.6
Polypodium glycyrrhiza	13	82	1.1	0-5.6	1.8
Oenanthe sarmentosa	13	36	3.3	0-25.8	7.8
Trisetum canescens	10	45	.8	0-6.1	1.8
Carex leporina	10	18	4.5	0-49.3	14.9
Galium triflorum	9	45	1.1	0-7.5	2.3
Hypericum anagalloides	9	18	1.3	0-9.8	3.2
Myosotis laxa	9	27	2.4	0-26.7	8.1
Phalaris arundinacea	8	55	1.0	0-3.9	1.5
Holcus lanatus	8	55	.4	0-2.3	.8
Rumex conglomeratus	6	45	.4	0-3.1	1.0
Carex tumulicola	5	9	.5	0-5.4	1.6
Taraxacum offinale	3	36	.3	0-1.3	.5
Cardamine oligosperma	2	18	.1	0-.4	.1
Carex stipata	2	18	.2	0-1.3	.5
Ranunculus occidentalis	2	18	<.1	0-.2	.1
Mentha arvensis	2	9	.5	0-5.1	1.5
Sanicula crassicaulis	2	18	<.1	0-.4	.1
Vicia americana	2	9	.2	0-2.8	.8
Athyrium filix-femina	1	27	.1	0-1.3	.4
Festuca arundinacea	1	18	.3	0-3.1	.4

Appendix 2 - Fraxinus latifolia/Symphoricarpos albus plant community cont.

Species	Microplot Constancy (%)[a] (n=132)	Macroplot Frequency (%)[b] (n=11)	Microplot Cover (%) Mean	Microplot Cover (%) Range	SD
Herb Layer Cont.					
Juncus bufonius	1	9	.1	0-1.3	.4

[a]Frequency within 132 Symphoricarpus albus community microplots.

[b]Frequency within 11 Symphoricarpos albus community macroplots.