AN ABSTRACT OF THE THESIS OF

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Title: A Plant Association Classification for McDonald-Dunn Forest

Abstract approved: Signature redacted for privacy.

William H. Emmingham

The purpose of this study was to develop a plant association classification for the mature coniferous forests of the McDonald and Paul M. Dunn Research Forests. A secondary objective was to quantify diversity within the plant associations. This Forest is approximately 11,000 acres and is located 6 miles to the north of Corvallis Oregon. This forest is owned and managed by the College of Forestry at Oregon State University.

This study, and a companion study by Leavell (1991), was funded by the Research Forest to broaden their understanding of the plant communities on the Forest. The companion study developed relationships between the plant associations and the environment.

Classification was based on 108 plots, using percent cover of trees, shrubs, forbs, and grasses. This sampling density of approximately 1 plot per 100 acres is much

greater than most community classifications in the area (Hemstrom & Logan, 1986; Hemstrom et al., 1987; Topik et al., 1988; Juday, 1976). A total of 117 vascular plant species were encountered; 68 of these were used in classification. Stands sampled for this classification were primarily seral, yet the most mature available. Few climax stands were available for sampling.

Plant associations were developed using TWINSPAN, a two-way indicator species analysis (Hill, 1979b). Six plant associations were developed and described in this study:

Tsuga heterophylla/*Acer circinatum*-*Gaultheria shallon*

Abies grandis/*Acer circinatum*-*Gaultheria shallon*

Abies grandis/*Disporum hookeri*-*Thalictrum occidentale*

Abies grandis/*Polystichum munitum*

Abies grandis/*Rubus ursinus*-*Rhus diversiloba*

Abies grandis/*Brachypodium sylvaticum*

One plant association, *Abies grandis*/*Acer circinatum*-*Gaultheria shallon*, parallels a previously described plant association described by Juday in the Valley Margin Zone (Juday, 1976). The other 5 plant associations described in this study are original descriptions.

The TSHE/ACCI-GASH, ABGR/ACCI-GASH, and the ABGR/RUUR-RHDI plant associations are shrub-dominated. ABGR/DIHO-THOC and ABGR/POMU are forb-dominated associations, and ABGR/BRSY is a grass-dominated plant association.

Plant associations were shown to have significant differences in species richness, heterogeneity, evenness, and in vertical structure. Average species richness per plot is highest in the ABGR/ACCI-GASH and ABGR/DIHO-THOC plant associations, which also has high relative diversity (Shannon's index) and evenness. Species richness is lowest in the TSHE/ACCI-GASH plant association, probably because it was represented only by seral stands.

Structural diversity included an analysis of snags. Snag number, size, and distribution were not related to plant associations. Current snag levels indicate that at most, 30 percent of the maximun populations for six woodpecker species could be supported on this Forest.

A description of each plant association is given. The description for each includes: extent, location, characteristic species, species richness and percent cover within four strata (trees, shrubs, forbs, and grasses), heterogeneity (Shannon's diversity index), and an evenness measure.

A Plant Association Classification

for McDonald-Dunn Forest

by

Connie J. Hubbard

A THESIS

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A PLANT ASSOCIATION CLASSIFICATION FOR McDONALD-DUNN FOREST

INTRODUCTION

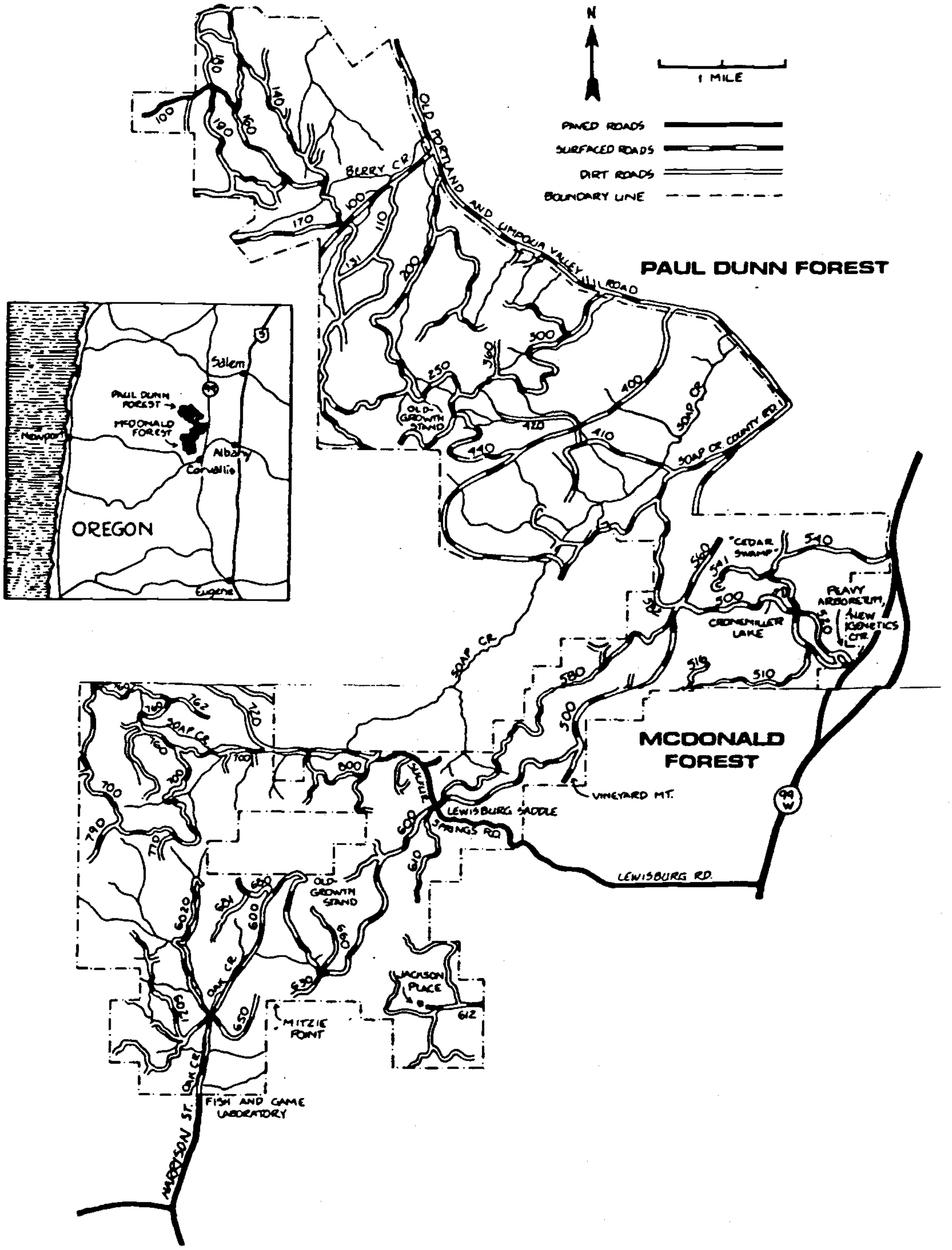
This study is a plant association classification for the McDonald and Paul M. Dunn Forests which includes an analysis of diversity measures. The College of Forestry at Oregon State University owns and manages the 11,000-acre Forest. For simplicity, these forests will be referred to as McDonald-Dunn Forest, or the Forest. The Forest is located northwest of Corvallis, Oregon (see Figure 1.).

BACKGROUND

It is human nature to classify; to categorize and organize information. Classification in general aims at grouping, condensing, or summarizing data in order to reveal an underlying structure, or organization.

This study is a result of the managers' desire to improve their knowledge of the Forests resources. Prior to this study quantitative information on vegetation was limited to that of trees. Plant association classification will improve the managers' knowledge of their floristic resource. Vegetation not only reflects the environment, but also provides wildlife habitat and aesthetic qualities to the Forest.

Figure 1. Location of McDonald-Dunn Forest.

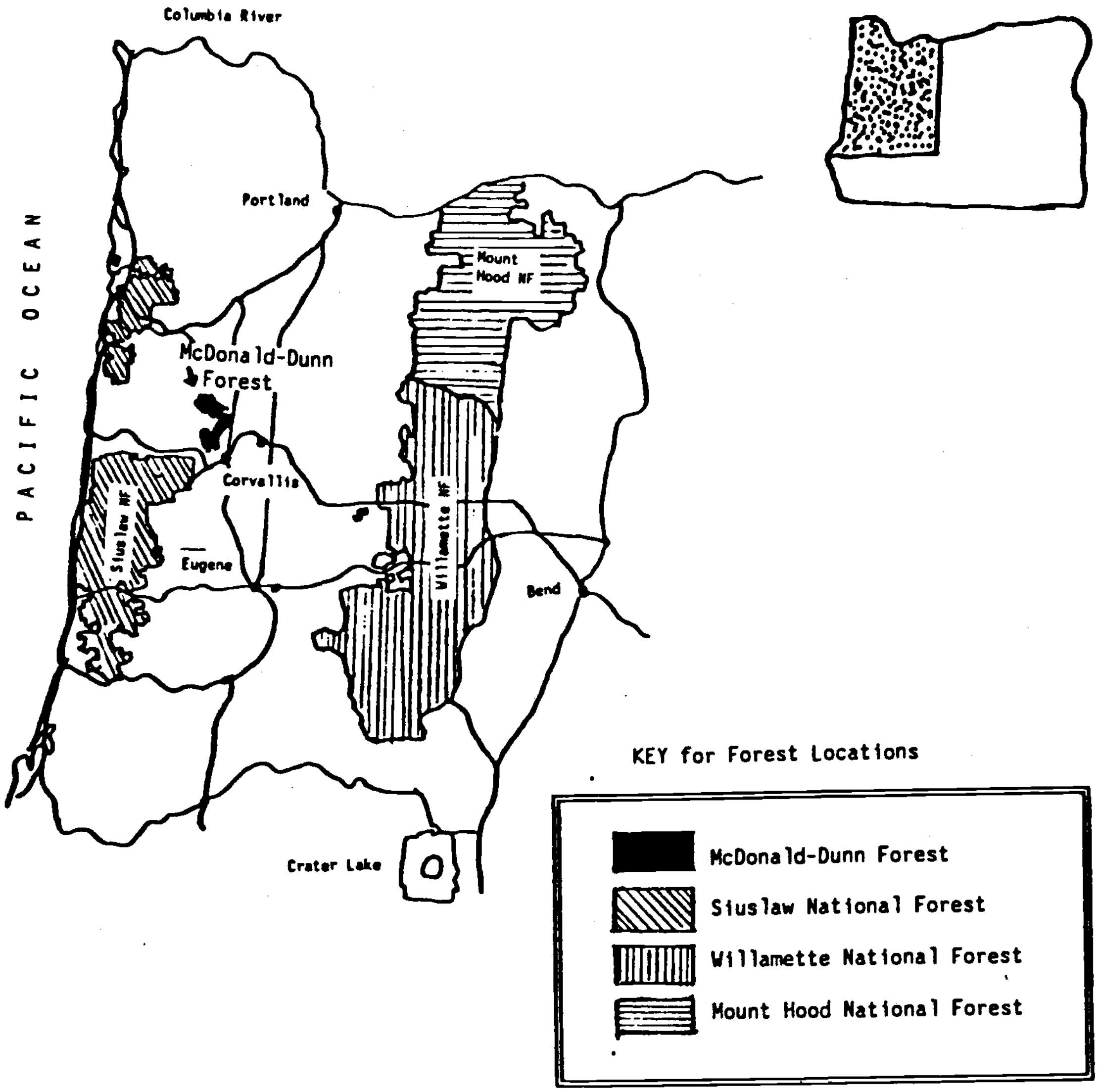


A companion project (Leavell, 1991) relates environmental variables to the vegetation structure and composition of the plant associations that were derived in this study for McDonald-Dunn Forest (Figure 2). These environmental variables are both simple and complex, and include measures of productivity. Together the two studies provide additional information for Forest managers.

Forest management agencies such as the USDA Forest Service use vegetation classification to provide managers with productivity, wildlife, and reforestation information (Hemstrom & Logan, 1986; Halverson et al., 1986, Hemstrom et al., 1987). Plant associations also provide information to evaluate resource condition, and to predict response to management (Hall, 1989).

Available USDA Forest Service plant association guides for this area (Hemstrom and Logan, 1986; Hemstrom et al., 1987) do not cover the floristic composition or environment of McDonald-Dunn Forest. These classifications do not apply to McDonald-Dunn Forest. McDonald-Dunn Forest has a drier climate than the Forest Service lands. Other classifications in the Oregon Coast and Cascade Ranges (Halverson et al., 1986; Dyrness et al., 1974) also do not adequately describe the communities in McDonald-Dunn Forest.

Figure 2. Location of McDonald-Dunn Forest in relation to the Siuslaw and Willamette National Forests.



OBJECTIVES

There were two objectives to this study.

The first objective was to develop and describe plant associations for the upland forest areas based on vegetation composition and cover in the Forest. This was accomplished through classification procedures.

The second objective was to quantify diversity within the plant associations. Measures of diversity such as; species richness, heterogeneity, evenness, and vertical structure (including snags) were calculated within plant associations.

LITERATURE REVIEW

There are two broadly conceived research methods dealing with the understanding of the relationships of plant communities to one another and to the environment. These are classification and ordination (also called gradient analysis) (Whittaker, 1973).

> "Classification groups communities into classes that may be characterized and treated as discontinuous with each other. Gradient analysis studies vegetation in terms of gradients of environment, species populations, and community characteristics in relation to one another. (Whittaker, 1973)."

The primary objective of this study was to organize vegetation data collected on McDonald-Dunn Forest into units, plant associations, by means of classification. The companion study (Leavell, 1991) used indirect gradient analysis to determine relationships between this vegetation (plant associations) and the environment.

A literature review on classification was conducted to accomplish three things: 1) to gain a historical perspective on the development of classification; 2) to determine which method of classification to use for this study; 3) to determine if any vegetation classifications have been previously done in McDonald-Dunn Forest.

Krajina (1959) synecologically classified forests at three levels: environmental, biocoenotic, and ecosystematic. According to Krajina, environmental classifications were sometimes limited to only macroclimatic differences. Cowles (1899), Clements (1902), and Tansley (1920) were some of the earliest ecologists to use this approach in the concept of plant formation (Krajina, 1959). Krajina cited Svoboda (1949) in saying this method of classification is artificial and incomplete because of a lack of understanding of the real effects of ecological action (reaction or coaction), though it provides good information on significant characteristics of the environment.

Biocoenotic classification is dominated by a phytocoenotic approach and is usually independent of environmental information (Krajina, 1959). According to

Krajina, this method of classification was initiated by Cajander (1909), Ilvesalo (1920), and Lakari (1920), all ecologists from Finland. The Zurich-Montpelier school, represented by Braun-Blanquet was also part of the phytocoenotic method of classification. Krajina cited Dansereau (1957) in saying the Zurich-Montpelier school:

> "invokes the floristic composition first and places almost exclusive emphasis upon it, trusting, as it seems, that association-characteristics embody the very ecological-pedological-climatic factors which determine them".

The ecosystematic or biogeocoenotic classification method combines both floristic and environmental classification methods (Krajina, 1959). Odum (1953), Woodbury (1954), and Oosting (1956) believe that the crux of ecological thinking is the holocoenotic (floristic and environmental) point of view (Krajina, 1959).

Shimwell (1971) reviewed the historical development of the units of classification. According to Shimwell, the concept of the **plant association** is "one of the oldest in plant geography, even pre-dating use of the term 'ecology' ". Shimwell cited Humboldt (1805) as being the first to use the term. Shimwell divided different trends in vegetation classification into three traditions: the Zurich-Montpelier Tradition, the Northern Tradition, and the English Tradition.

The Zurich-Montpelier Tradition used the term association as "the fundamental vegetation unit characterized by physiognomic dominants" (Shimwell, 1971). This definition was adopted from Flahaut (1893). Shimwell cited Brockman-Jerosch (1907) as being the first to advocate classification of vegetation by dominant indicator species, but also by constancy as a basis for characterization. "Constant" species were those species occurring in better than 50% of samples in an association. The Zurich-Montpelier Traditionalists encouraged the 1910 International Botanical Congress to adopt the following definition of association (Shimwell, 1971):

> "An association is a plant community of definite floristic composition, presenting a uniform physiognomy, and growing in uniform habitat conditions."

According to Shimwell, Braun-Blanquet (a leading representative of the Zurich-Montpelier Tradition), put increasing importance on vegetative classification while placing environmental influence into the background. Shimwell said the term "differential" species was initiated by Braun-Blanquet and Jenny (1926). Differential species applied to vegetation units lower than the level of plant association.

The English Tradition, according to Shimwell, combines British and American ecological influence. Pound and Clements (1898) adhered to the formation concept. Shimwell referred to Drude's (1896) definition of formation:

> "... (a) any principal association which has found its natural termination in itself, (b) which consists of biologically related life forms, (c) (and) which is confined to similar substrata...This association...has reached its climax development." (Shimwell, 1971).

According to Shimwell, Clement's work became overshadowed by the continuum approach of Whittaker (1962).

The Northern Tradition started with the Scandinavian concept of ecological series of communities along environmental gradients (Norrlin, 1870; Cajander, 1903). The Northern Tradition gradually merged in conceptual philosophy with the Zurich-Montpelier Tradition .

Whittaker (1973) also gave a history of classification similar to Shimwell's, but with the addition of the Russian Tradition and a separate American Tradition. According to Whittaker, early classifications completed by the Russian Traditionalists were mainly physiognomic. Sukacev (1928) and Alekhin (1936) were early community ecologists who arranged communities in series along environmental gradients. According to Whittaker, the Russian Traditionalists mainly view forest communities as landscape units or biogeocoenoses (Sukacev, 1945).

Whittaker (1973) also wrote of the development of the American Tradition with the debate of the "unit" versus the "continuum" concept. Cowles (1899) and Clements (1905) advocated vegetative organization made up of discrete units of similar vegetation (associations). According to

Whittaker, these units were climax communities adapted to the "climates of geographic regions". The American Tradition developed from the unit concept of vegetation organization to the continuum concept, initially advocated by Gleason (1926). The continuum concept places vegetative species independently along environmental gradients (Gleason, 1926). Whittaker (1967), Curtis (1959), and MacIntosh (1967) are all proponents of the continuum concept of community analysis, and all representatives of the American Tradition.

Community ecologists have applied plant community classification in the Pacific Northwest (Daubenmire, 1952; Hall, 1973; Pfister et al., 1977; Hemstrom et al., 1987; and many more). These classifications place plant communities into units such as habitat types or plant associations. Community ecologists in the Pacific Northwest are using both classification and gradient analysis to discover and describe plant associations (Atzet, 1978; Hall, 1989).

Historical insight was important to understand the role of classification in this study. A further review of more recent literature was done to decide which classification method would be used in this study.

"Classification techniques used in community ecology may be considered in three groups : table arrangement, hierarchical, and nonhierarchical classification (Gauch, 1982). Braun-Blanquet (1932) initiated the table arrangement method. The table arrangement approach orders samples-by-species data by placing samples and species into an order that best illustrates community organization. Similar species listed are placed together, dissimilar species are placed apart. Braun-Blanquet based classification on the differential species in the communities. Whittaker (1973) said the Braun-Blanquet method:

> "...is the most widely applied and most effectively standardized of all approaches to classification, and has been adapted to diverse kinds of vegetation."

Although this method is widely used, it has the following limitations:

1. Ecologists need to be trained for the method;
2. It is fairly subjective; and
3. It is not suited for large data sets.

Gauch (1982) stated nonhierarchical classification places similar samples or species into clusters. These clusters demonstrate no inherent relationships between each other. Gauch further suggested nonhierarchical classification should be used as an initial clustering for large data sets to reduce outliers and redundancy.

According to Gauch (1982), hierarchical classification puts similar samples or species into groups (as in the nonhierarchical method), but the groups are also arranged hierarchically. The hierarchy indicates relationships among the groups. Gauch described three methods of hierarchical classification: monothetic divisive, polythetic agglomerative, and polythetic divisive.

The monothetic divisive approach starts with all plots in a single cluster and then divides them into groups based on presence or absence of a single species (monothetic = 1 species). Polythetic means information on greater than one species is used. In the polythetic agglomerative method, information on more than one species is used. It starts out with each plot in its own cluster and systematically links the plots together on the basis of similarity or other criterion. The polythetic divisive method also uses information on more than one species. The plots start out in one cluster and are subsequently subdivided into groups.

Orloci (1966) said monothetic classifications have the disadvantage of producing uninformative subdivisions on the basis of unimportant attributes. Madgwick and Desrochers (1971) used a monothetic association-analysis method to classify forest vegetation of the Jefferson National Forest. One conclusion from their classification study was "...all monothetic classifications suffer from problems arising from divisions on the presence and absence of a single (monothetic) characteristic".

Lambert et al., (1973) developed two polythetic-divisive methods for hierarchical classification. They said the only polythetic methods in use as of their writing had been agglomerative. They went on to say there are "...theoretical advantages in that all the available information is used to make the critical topmost divisions".

Hill et al., (1975) used a divisive polythetic method of classification to classify native pinewoods in Scotland. According to the authors, agglomerative methods of classification can be "...strongly dependent on the way in which stands are clustered at the lower levels." Divisive methods have an advantage in using the overall structure of the data set initially, with higher levels of the hierarchy being insensitive to the lower levels. The authors also stated that the monothetic divisive method of association-analysis "makes far too many misclassifications". The authors developed a polythetic divisive classification method based on the iterative algorithm technique used in the ordination method of reciprocal averaging (Hill, 1973). The method was called indicator species analysis (Hill et al., 1975).

Hill (1979b) modified the indicator species analysis program to produce a two-way indicator species analysis program (TWINSPAN). This FORTRAN program differed from the indicator species program by the following:

1. The program first constructs a classification of the samples, then uses this classification to obtain a classification of species:

2. The two classifications (species and samples) are used together to produce a two-way table which illustrates the synecological relationships of the species.

The TWINSPAN program creates a "tabular matrix arrangement which approximates the results of the Braun-Blanquet tablework" (Gauch, 1982). TWINSPAN incorporates two of the three basic methods of classification. It is hierarchical and includes a tablework arrangement. Gauch also said TWINSPAN is objective as compared to the subjectivity of the Braun-Blanquet tablework method.

From the literature review it was determined that the hierarchial polythetic divisive method and the program TWINSPAN would be used for classification in this study. Ecologists in the Pacific Northwest such as Hemstrom (1990), Atzet (1990), Smith (1990), and Diaz (1990), all personal communication, have used or are using the TWINSPAN program for vegetation classification.

The literature was also consulted to determine whether or not there were any existing classifications for the McDonald-Dunn Forest, or if any of the classifications for the surrounding country could be applied to this forest. Literature was reviewed for <u>Tsuga heterophylla</u>, <u>Abies</u>

grandis, and Pseudotsuga menziesii communities in Western Oregon.

Hall and Alaback (1982) surveyed vegetation on McDonald-Dunn Forest and developed a checklist if vascular plants. West (1964) mapped vegetation on McDonald-Dunn Forest. West's project was a classification, but based only for trees. West devised an elaborate mapping system and map for the Forest illustrating shrub, forb, and grass cover for taxa with greater than 5% cover. Unfortunately, neither the Forest nor West (personal communication) could locate the maps or any of the original data in 1989.

A successional study of McDonald-Dunn Forest was completed by Sprague and Hansen (1946). This study concentrated on arboreal vegetation rather than all strata of vegetation. Sprague and Hansen provided insight into succession of tree species on the Forest. Their study indicated a "successional trend of white oak to Douglas-fir followed possibly by a climax forest of lowland white fir (sic, Abies grandis) or a Douglas-fir lowland white fir association" (Sprague and Hansen, 1946).

Sabhasri and Ferrell (1960) did a study "to determine the effects of some environmental variables on the species, numbers, degree of cover, age, and growth of shrub species on south slopes in McDonald and Dunn Forests." Sabhasri and Ferrell's work provided some information on succession for a few shrub species, but not on classification.

Bigleaf maple, poison-oak, hazel, snowberry, and wild rose were studied. It was found that bigleaf maple, hazel, and snowberry had greater cover in openings than under the canopy. Poison-oak decreased in percent cover when a stand is opened. "Poison oak could very well be considered a climax community shrub on south slopes in this area" (Sabhasri & Ferrell, 1960). Wild rose showed no significant reaction to openings in the canopy.

There was no existing plant association classification for McDonald-Dunn Forest prior to this study. Vegetation studies in the Coast Range have been done by Juday (1976), Merkle (1948), Anderson (1967), Bailey (1966), Hemstrom and Logan (1986), and Thilenius (1968). I have reviewed these studies and vegetation studies in the Oregon Cascade Range (Hemstrom et al., 1987; Halverson et al., 1986; Topic et al., 1988; Means, 1980; and Dyrness et al., 1974.

From review of the above vegetation studies it was determined that McDonald-Dunn was locationally, climatically, and vegetationally different from these existing classifications. There were very few _Abies grandis_ associations in these classifications.

THE STUDY AREA

The location, climate, soils, and land use history of McDonald-Dunn Forest contribute to its unique complex of plant communities.

LOCATION

The study area is the McDonald and Paul M. Dunn Research Forest. The Forest is owned and managed by Oregon State University's College of Forestry. The Forest consists of approximately 11,000 acres of predominantly forested land on the western edge of the Willamette Valley in Oregon, and on the eastern foothills of the Coast Range (Figure 3).

McDonald-Dunn Forest is in Townships 10 and 11 South, and Range 5 West, Willamette Meridian. It lies west of U.S. Highway 99 just to the north of Corvallis. The Forest occupies a ridge system that projects eastward into the Willamette Valley (Figure 3). In general, the streams and ridges extend northwest and southeast from the main ridge (Sprague and Hansen, 1946). The Forest is somewhat isolated topographically from the rest of the Oregon Coast Range, residing in the rain shadow created by it. McDonald-Dunn Forest is in the "Valley Margin Zone" as defined by Juday (1976) (Figure 4).

Figure 3. McDonald-Dunn Forest shown in relation to the Willamette Valley.

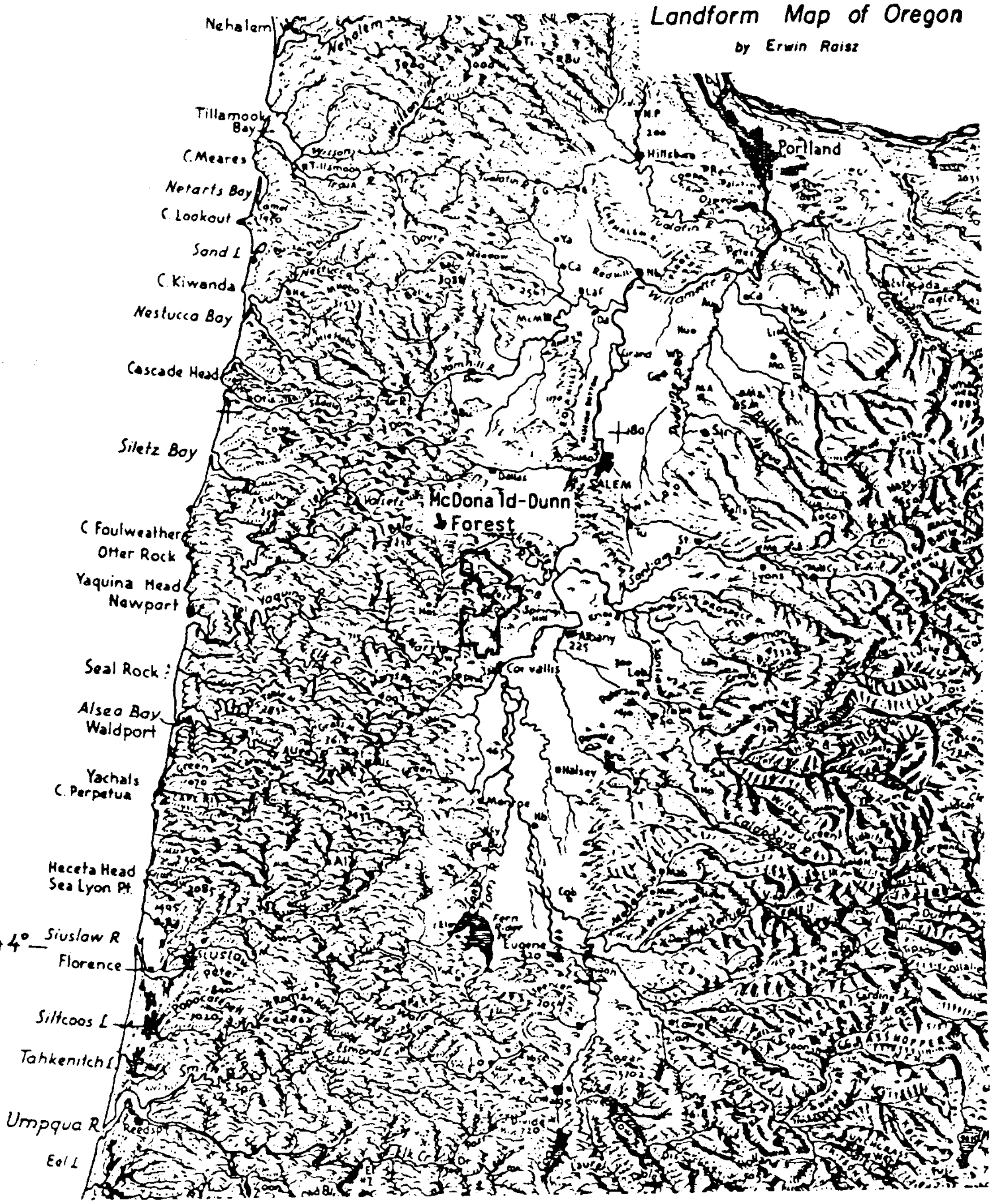
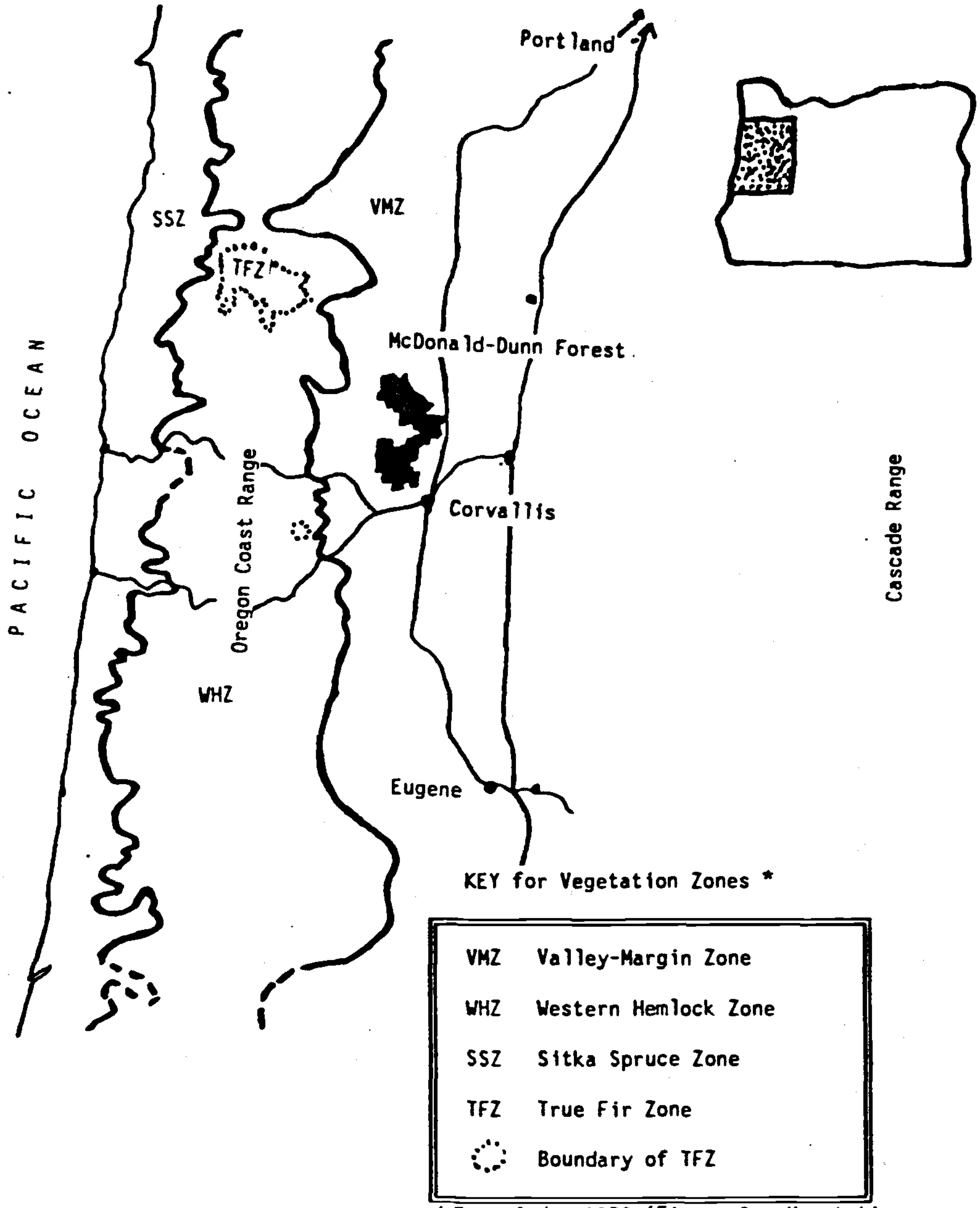


Figure 4. Valley Margin Zone[1].



[1] From Juday 1976 (Figure 3. Vegetation of the Oregon Coast Range).

CLIMATE

The climate of the McDonald-Dunn Forest is different than adjacent forests. The forests to the west have a greater coastal influence, with greater annual precipitation. McDonald-Dunn Forest is in the rain shadow of the Coast Range, receiving 100 to 150 cm of rain annually (Hall and Alaback, 1982), while the heart of the Oregon Coast Range receives 150 to 300 cm annually (Franklin and Dyrness, 1984). The Forest's climate is more influenced by the drier Willamette Valley climate than the typically wet Oregon Coast Range climate.

The macroclimate is summer-dry and winter-wet (Waring and Franklin, 1979). Precipitation occurs only occasionally in the summer. Rain gear was worn only once during the June-October field season in which the data for this study were collected. Most precipitation occurs in the winter.

SOILS

The soils of this study area have been intensively surveyed (Rowley and Jorgensen, 1983). Thirteen soil series were identified and mapped. These are: McAlpina, Abiqua, Waldo, Jory, Price, Ritner, Witzel, Dixonville, Philomath, Dupee, Hazelair, Panther, and Steiwer. Soil series descriptions in Rowley and Jorgensen follow those of Knezevich (1975) in the soil survey for Benton County. Only nine of these series were sampled in this study. McAlpina, Waldo, Dupee and Panther were not sampled because they are relatively uncommon on the Forest. Rowley and Jorgensen (1983) provided a description of the parent materials for the Forests soils:

> "The parent material for most of McDonald and Dunn Forests soils is from the Siletz River Volcanics, a basalt formation. This rock formation is the foundation for the ridges and underlies most of the valleys. It underlies the Jory, Price, Ritner, Witzel, Dixonville, and Philomath series. The Flourney Formation (Tyee sandstone) is concentrated in the northwest corner of Dunn Forest and is the base for Dupee, Hazelair, Panther and Steiwer series. The wide flat drainage bottoms are recent alluvium which form the basis for McAlpina, Abiqua and Waldo series."

The soil survey, completed in 1983, produced the soils map used in this study. Soil types were one criteria used in stratifying plot location.

HISTORY

The McDonald-Dunn Forest has a complex history of settlement, ownership, use, and management. Prior to the migration and settlement of Anglos into the Willamette Valley in about 1845, Indians had burned the countryside repeatedly to facilitate game hunting and to maintain certain plants for food (Sprague and Hansen, 1946). Growth ring studies show that the country was frequently burned since 1647, and less frequently burned after 1848 (Sprague and Hansen, 1946). Burning had kept the vegetation along the fringe of the Willamette Valley in an early successional stage, where open, savanna-like Quercus garryana groves persisted. With Anglo settlements came fire suppression. With fire suppression came the slow conversion of the Quercus garryana savanna into Quercus garryana-Pseudotsuga menziesii forests. Abies grandis was also a component of these forests. Today there are fewer Quercus garryana forests and more Pseudotsuga menziesii/Abies grandis forests, although much of the Forest still contains Quercus garryana remnants.

Human settlement in the area brought cattle, sheep, pigs, horses, mules, and oxen into the foothills of Benton County in the 1850's (Jackson, 1981). Wild goats, originating from abandoned domestic herds, ranged the Forest in the 1930's. These foraging animals (along with deer) had an impact on vegetation, especially to young seedlings and small trees (Jackson 1981). Domestic livestock grazing has ceased on the Forest.

In 1953, the Oregon Game Commission organized a special deer hunt in the McDonald-Dunn Forest. One objective for this special hunt was to provide relief from deer browsing damage on Pseudotsuga menziesii seedlings (DeCalesta, 1985). Browsing pressure from deer still exists. Approximately 260 black-tailed deer were harvested from the Forest annually between 1959 and 1982 (DeCalesta, 1985).

Although most of the funds for acquisition of the McDonald-Dunn Forest were donated by Mary J. L. McDonald, the tracts of land came from mixed previous ownership, and therefore have a variety of previous impacts. "Much of the land had been logged prior to being acquired by the School" (Jackson, 1981).

In 1989 Marvin Rowley, McDonald-Dunn Forest manager from 1973 to 1987, wrote histories for all stands in the Forest, recollecting most activities occurring prior to and during his management regime. Rowley's histories are the best source of historical logging activities available for the stands sampled in this study.

Forest management has had an impact on the species composition of the Forest. Harvesting activities under different Forest managers varied. Harry Nettleton, forest manager from 1948-1959, was characterized as "custodial", and emphasized protection of forest resources (Jackson, 1981). William Davies (manager from 1959-1973) and Marvin Rowley (manager from 1973-1987) emphasized productivity and implemented thinning programs. Current management under Jeff Garver (1987 to present) is more intensive, with clearcuts becoming more frequent than in the past. Besides harvesting and homesteading, Forest lands were used for many other activities such as the Civilian Conservation Corps, research, recreation, and military activities.

METHODS

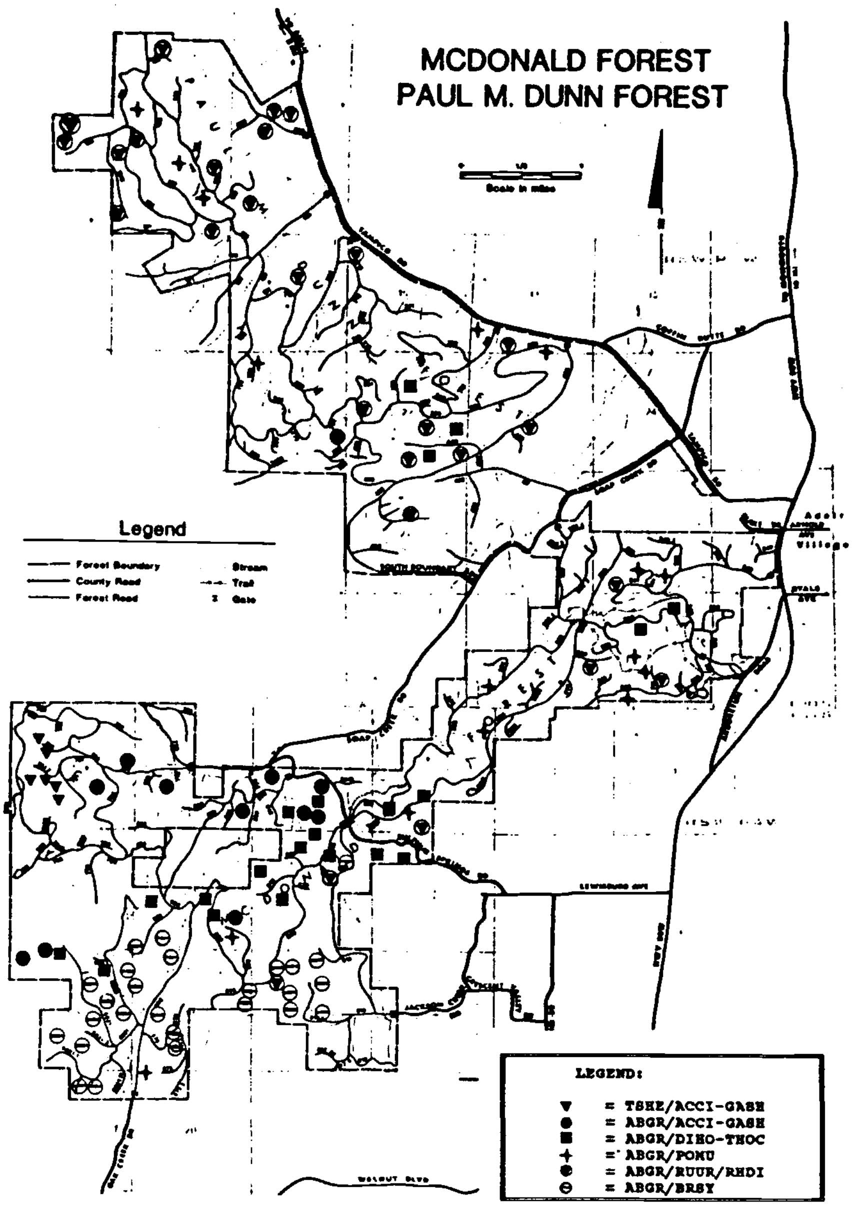
Data were collected on 115 plots during the field season beginning in June and ending in September of 1989. Plots completed in this study are called ecology plots. Location of ecology plots is found in Figure 5. The Forests tract, compartment, inventory plot number, and Township, Range, Section, and are identified for each ecology plot in Appendix 1.

STAND SELECTION

Ecology plots were placed within stands representing the overall resource variability in the Forest (excluding riparian areas). An initial ground reconnaissance indicated potential plant community variability. Topographic maps were consulted for physiographic variability. The soils inventory completed on the Forest (Rowley and Jorgensen, 1983) provided possible soil series differences. The most current timber type map for the forest was also studied. Timber typing was done according to the type mapping system devised by the USDA Forest Service (USFS, 1962).

The ecology plots were stratified on the basis of community type, physiography, soils, and timber type. The sampling objective was to obtain representative plots in

Figure 5. Location of ecology plots in McDonald-Dunn Forest.



all combinations of these features. Stands selected met the following criteria:

1. Mature; oldest stands available on the Forest.
2. Relatively undisturbed; stands not disturbed within the last 10 years, or stands where understory vegetation did not reveal any recent disturbance.

The relatively small area encompassed by McDonald-Dunn Forest allowed sampling of all stands that met the above criteria. Approximately 25% of the Forest area was initially eliminated by stands clearly too young (sapling size or smaller) to be considered in this classification. Many more stands were eliminated because of apparent recent disturbance.

ECOLOGY PLOTS

In this study, the plots are called ecology plots but are often referred to as just "plots". The Forests' timber inventory plots are referred to as inventory plots.

LOCATING ECOLOGY PLOTS

Once a qualified stand was located, Forest inventory plots already in place were selected for sampling before the stand was entered. An inventory plot in the interior of the stand was chosen. If this inventory plot did not fit desired criteria (relatively undisturbed, relatively homogeneous in vegetation, soils, and physiography) the next plot in the transect was visited and evaluated. We continued down the transect in this manner till an appropriate inventory plot was located. If this transect failed to provide an appropriate plot, plots on an adjacent transect were evaluated. Ecology plots were not located on ecotones (obvious changes in vegetation composition within a short distance) or within riparian areas. Riparian areas require a different sampling scheme than the one used for this classification.

Ecology plot centers were placed on existing Forest inventory plot centers. This was done for several reason:

1. Non-bias; Inventory plot centers were systematically "surveyed in" by Forest engineers. Plots occur as frequently as every 200 (1 plot/acre) feet along predetermined transects.
2. Relocation; Plots will be relocated and measured every 10 years by the Forest. Each inventory plot has two bearing trees with aluminum tags giving azimuth and distance to plot center. This assists in locating ecology plots in the future for successional or other vegetation studies.
3. Simplified data collection; Information on the trees (species, diameter, height, site index,

basal area, age, growth, etc) was available from the Forest's inventory data base and did not have to be measured. This facilitated timely collection of a sufficient number of ecology plots.

ECOLOGY PLOT IDENTIFICATION

Ecology plots were circular, with an area of 5382 ft^2 (500 M^2) (uncorrected for slope), or a radius of 41 feet. Ecology plot centers were marked with 2" X 2" X 18" wooden stakes. An aluminum identification tag with ecology plot number, Forest inventory plot number, and date of establishment was nailed to the top of this stake.

Two black and white photographs and two color slides were taken from each plot center for a permanent record of the site. These photographs and slides were taken in the two opposing directions that best captured the floristic composition of the stand. Photographs and slides were taken with 35 mm cameras; photographs with a wide angle lens (28 mm), slides with a 50 mm lens. The tripod for the cameras was placed approximately 4 feet above ground level directly over plot center. Occasionally the tripod could not be placed on plot center because a mature tree was too close, or blocked the best view of the stand. When this happened, the distance and azimuth that the camera was offset from plot center was noted on ecology plot sheet 1. The photo-point record is on file at the Research Forest headquarters in Peavy Arboretum.

ECOLOGY PLOT DATA

The four data sheets and a detailed description of data collected appear in Appendices 2 and 3. A short description of data collected on each plot sheet follows.

1) Ecology plot card 1 included information on plot location, physiography (slope, azimuth, microposition), vegetation structure, surface characteristics, average tree height and diameter, site index, stand density index, snags, and vertical complexity of vegetation. Total live basal area, average stand height, average site tree age, quadratic mean diameter, site index, and stand density index were obtained or calculated from the Forests' inventory data bank.

2) Ecology plot card 2 consist of percent canopy coverage of all trees, shrubs, forbs, and grasses (complete species list in Appendix 4). Percent canopy cover was ocularly estimated. Canopy cover is defined as:

> "the percentage of ground covered by a polygon drawn around the extremities of the undisturbed canopy of a plant species. Individual canopy coverages are then summed to represent the total canopy coverage for that particular species. (Daubenmire, 1959)"

Tree species had three categories of canopy cover: trees <12 feet, 12-50 feet, and >50 feet in height. Heights were estimated.

3) Soil description were completed for the top 60 inches of the soil profile (less if the profile was shallow). A soils pit was dug to 18 inches, and the remainder of the 60 inches of soil was described from an auger core. Depth, color, texture, and percent coarse fragments of major horizons, were recorded. Soil series were determined from those described in the 1983 soil mapping guide for McDonald-Dunn Forests (Rowley and Jorgensen, 1983).

4) The historical commentary included observations of disturbance history, stand succession and structure, and degree of recovery from disturbance. Stand histories written by Marvin Rowley were also consulted.

DATA STORAGE

Data from plot card 1 and the soil descriptions were entered in dBASE III (1985). Data from plot card 2, vegetation cover percents, were entered into a Quatro Pro spreadsheet (Quatro Pro Manual, 1987). Original plot sheets, photos, and slides are in the Research Forest office at Peavy Arboretum. The data collected in this study, with the exception of the historical commentary, was entered into the Forest Science Data Bank (Stafford et al., 1984) in the College of Forestry's Forest Science Department.

ANALYSIS

Analysis of the data collected for this study was accomplished in two parts: classification and diversity.

Classification facilitated the primary objective of this study: developing and describing plant associations. The classification program used was TWINSPAN (Hill, 1979b). Once plant associations were derived, significant differences between them were tested. This verification test was accomplished through a non-parametric procedure called MRPP, multi-response permutation procedure, to test the hypothesis of no significant difference among the associations. Quantification of diversity includes measures of richness, heterogeneity (Shannon's diversity), evenness, and vertical structure (which includes snags).

CLASSIFICATION

Species percent cover, as ocularly estimated on the 5382 ft^2 (500 m^2) field plots, was used for classification into plant associations. Since there were many ubiquitous species throughout the sampling area, percent cover was more meaningful than presence/absence data. Plant association, as used here, primarily follows the 1910 International Botanical Congress definition:

> "An association is a plant community of definite floristic composition, presenting a uniform physiognomy, and growing in uniform habitat conditions."

But the term association for this study also refers to potential climax. The aim is to be able to identify the same plant associations in the future when communities are closer to climax. Most plant communities in McDonald-Dunn Forest have not attained a climax state and are seral due to past disturbance and age. Even though most of the Forest communities are seral, it was important to highlight potential climax tree species in order to place the associations described in this study within the context of western Oregon classifications. The potential climax tree species for the purposes of this study is the most shade tolerant tree species present and reproducing successfully on the site.

Plant association classifications developed in the Pacific Northwest use climax tree species to identify series, and shrubs, forbs, or grasses to identify associations (Hemstrom and Logan, 1986; Halverson et al., 1986; Topik et al., 1988; Hemstrom et al., 1987). This study follows the same naming pattern. Hemstrom et al. (1987) defined plant associations as follows:

"After a relatively long disturbance-free period, only those plants which can grow and reproduce in competition with their neighbors remain. This long-term stable collection of plants is the plant association."

Communities sampled in this study are as close to the climax state as available, taking into account the full range of vegetative diversity found in the Forest.

A total of 117 species were identified on the 115 ecology plots. Hitchcock and Cronquist (1973) were the taxonomic authority for nomenclature. Common names not listed in Hitchcock and Cronquist were found in either Gilkey and Dennis (1980) or Garrison et al. (1976). A complete species list with numerical codes, acronym, scientific and common names is in Appendix 4. Acronym names are from Garrison et al. (1976). Acronym names are usually represented by the first two letters of both the genus and species of a taxa. Species not identified in Garrison et al. were generally named by the first two letters of both the genus and species. A complete list of species and cover percent on each plot is in Appendix 5.

Twinspan

TWINSPAN (Hill, 1979b) was the program used for classification analysis. Species cover data was formatted to be compatible with this classification program by a program called CONDENSE (Singer and Gauch, 1979). TWINSPAN is a program in the Cornell Ecology Program series (Gauch, 1981). This program was a development of a previously published classification method called "indicator species analysis" (Hill et al., 1975). TWINSPAN is a hierarchial polythetic divisive method of classification. Being hierarchial facilitates the construction of a dichotomous key for the associations, which can be used to identify associations in the field.

The name TWINSPAN stands for Two-Way INdicator SPecies ANalysis. It is called two-way because it classifies both plots and species. It is called indicator species analysis because it identifies one or more species, called indicator species, that are diagnostic of each division created in the classification.

The basic method of TWINSPAN involves the division of three ordinations. The first ordination is called the "primary ordination". It involves reciprocal averaging and orders plots. The second ordination is called the "refined ordination". The refined ordination is produced by making a dichotomy of the plots in the primary ordination. The dichotomy of the plots is made through identification of differential species, or species that show preference to one side or the other of the dichotomy (because of habitat or environmental preference). The refined ordination is divided in such a manner until the desired number of levels in the dichotomy obtained.

The third ordination is called the "indicator ordination". This ordination is based on the most strongly differential species and is used for a succinct characterization of the dichotomy (Hill, 1979b). It is used to identify indicator species. The indicator species are used in the dichotomous key which can be used to identify associations in the field.

Twinspan constructs two-way tables by identifying differential species[1]. Differential species drive the classification. Species are ordered according to their ecological preferences within this table. "The table created by TWINSPAN is ordered to exhibit the relationship between species and samples as clearly as possible" (Hill, 1979b).

The species percent cover data file was systematically modified to derive a classification (through TWINSPAN) that revealed as much structure as reasonable within the data set. The first runs through TWINSPAN included all plots and species, and used default input parameters. One very important input parameter is the pseudospecies cut levels. Pseudospecies are defined as the quantitative equivalent of differential species (Hill et al., 1975). Pseudospecies cut levels determine the particular scale of cover used during the classification process. The TWINSPAN program

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[1] Differential species are those with clear ecological preference (Hill, 1979b). Ecological preference is preference for habitat or environment.

makes divisions (in the ordinations) by implementing assigned pseudospecies cut levels. The default pseudospecies cut levels are: 0, 2, 5, 10, 20. These pseudospecies cut levels relate directly to a five point percent cover scale:

1 = >0-1%	4 = 10-19%
2 = 2-4%	5 = 20-100%
3 = 5-9%	

These default species levels did not illuminate satisfactory pattern or organization in the data set, and other pseudospecies cut levels were used.

To simulate the Braun-Blanquet (Westhoff and Maarel, 1973) classification method, cut levels were changed to 0, 5, 26, 51, and 76. These cut levels also did not illuminate satisfactory organization in the data. Differentiation in percent cover greater than 20 into a number of abundance levels was necessary to illuminate sufficient patterns in this data set. Many pseudospecies cut levels were tried.

The pseudospecies cut levels providing the most effective and useful TWINSPAN output were: 0, 6, 11, 21, 31, 41, 51, 61, and 76. These cut levels relate directly to species percent cover on this nine point scale:

1 = >0- 5%	4 = 21-30%	7 = 51-60%
2 = 6-10%	5 = 31-40%	8 = 61-75%
3 = 11-20%	6 = 41-50	9 = 76-100%

The nine point scale also directly relates to the values in the body of the two-way table produced by TWINSPAN (Table 2, page 51). The values 1-9 represent the cover of each species within each plot in this table. The output produced from TWINSPAN based on these cut levels, derived vegetative groupings that felt intuitively accurate, yet were reached primarily objectively.

TWINSPAN analysis was also made giving rare species greater weight. This was done by changing pseudospecies cut levels to 0, .2, .6, 2, 6, 11, 21, and 31, or 0, .6, 2, 6, 11, 21, 31, 51, and 76. These cut levels did not reveal additional floristic distinction in the data. Giving rare species more weight as indicators could also make it more difficult for field crews to identify the plant associations.

After a few initial TWINSPAN runs it became apparent that all species were not necessary to derive a classification. A total of 68 species were used for the majority of the classification analysis. A list of species used in the classification analysis are listed in Table 1. Species not used in the classification were trees, undesirable plants, and species that occurred in fewer than three plots.

Tree species were not used in the final TWINSPAN analysis. With or without tree species, preliminary analyses produced two-way TWINSPAN tables with similar results. Removing trees from the analysis also allowed

Table 1. Species used in TWINSPAN classification[1] .

	SHRUBS	
ACCI	Acer circinatum	vine maple
AMAL	Amelanchier alnifolia	western serviceberry
BEAQ	Berberis aquifolium	Oregon hollygrape
BENE	Berberis nervosa	Cascade hollygrape
COCO	Corylus cornuta	hazel
GASH	Gaultheria shallon	salal
HODI	Holodiscus discolor	ocean-spray
LOCI	Lonicera ciliosa	western trumpet honeysuckle
LOHI	Lonicera hispidula	hairy honeysuckle
RHPU	Rhamnus purshiana	cascara buckthorn
RHDI	Rhus diversiloba	poison oak
RIDI	Ribes divaricatum	straggly gooseberry
ROSA	Rosa spp.	rose
RULA	Rubus laciniatus	cutleaf blackberry
RULE	Rubus leucodermis	black cap raspberry
RUPA	Rubus parviflorus	western thimbleberry
RUPR	Rubus discolor	Himalaya blackberry
RUUR	Rubus ursinus	trailing blackberry
SAGL	Sambucus glauca	blue elderberry
SYAL	Symphoricarpos albus	common snowberry
SYMO	Symphoricarpos mollis	mountain snowberry
VAPA	Vaccinium parviflorum	red whortleberry
	FORBS	
POMU	Polystichum munitum	western swordfern
PTAQ	Pteridium aquilinum	bracken fern
ACTR	Achlys triphylla	deerfood vanillaleaf
ACRU	Actaea rubra	baneberry
ADBI	Adenocaulon bicolor	pathfinder
ANDE	Anemone deltoidea	wind-flower
ARMA	Arenaria macrophyllum	bigleaf sandwort
ASCA	Asarum caudatum	wild ginger
CASC	Campanula scouleri	Scouler's hairbell
COLA	Coptis laciniata	cutleaf golden thread
DIFO	Dicentra formosa	Pacific bleedingheart
DIHO	Disporum hookeri	Hooker's fairybells
FRVE	Fragaria vesca	common strawberry
GAAP	Galium aparine	cleavers
GATR	Galium triflorum	sweetscented bedstraw
GOOB	Goodyera oblongifolia	rattlesnake plantain
HIAL	Hieracium albiflorum	hairy hawkweed
HYOC	Hydrophyllum occidentale	western waterleaf
IRTE	Iris tenax	Oregon iris

Table 1. (cont.)

	FORBS (cont.)	
LAMU	Lactuca muralis	lettuce
LATHY	Lathyrus spp.	
LIAP	Ligusticum apiifolium	lovage
MOSI	Montia siberica	Siberian montia
NEPA	Nemophilia parviflorus	small flowered nemophilia
OSCH	Osmorhiza chilensis	sweet mountain cicely
PRVU	Prunella vulgaris	common selfheal
SACR	Sanicula crassicaulis	snakeroot
SADO	Satureja douglasii	yerba buena
SEJA	Senecio jacobaea	tansy ragwort
SMRA	Smilacina racemosa	false solomon's seal
SMST	Smilacina stellata	stary false solomon's seal
STCR	Stellaria crispa	chickweed
SYRE	Synthyrus reniformis	spring queen
TEGR	Tellima grandiflora	fringecup
THOC	Thalictrum occidentale	western meadowrue
TRLA	Trientalis latifolia	western starflower
TROV	Trillium ovatum	Pacific trillium
VAHE	Vancouveria hexandra	inside-out flower
VECAC	Veratrum californicum caudatum	false helibore
VICIA	Vicia spp.	
VIGL	Viola glabella	pioneer violet
VISE	Viola semperviern s	redwoods violet
	GRASSES (including grasslike plants)	
BRSY	Brachypodium sylvaticum	false brome
BRVU	Bromus vulgaris	Columbia brome
CAREX	Carex spp.	sedge
FEOC	Festuca occidentalis	western fescue

[1] Hitchcock and Cronquist (1973) was the taxomonic authority for nomenclature.

more emphasis to be placed on understory vegetation, which more accurately characterizes sites, since tree species cover and presence have been affected by management operations. Only 16 out of 115 ecology plots were in stands that had no known timber management disturbance in the past. Sixty-nine plots were in stands that were thinned once, 26 plots were in stands that were thinned twice, and 4 plots were in stands that were thinned three times (Rowley, 1989). In the stands sampled, thinnings removed an average of 5 to 8 MBF (thousand board feet) per acre (Rowley, 1989).

Weedy species were removed as they are transitory in nature and are not a natural part of the community. Species occurring in fewer than three plots were removed from the analysis because they created noise in the results; they did not add any additional interpretational value to the classification.

At one point in the analysis, ubiquitous species and species with less apparent indicator value were removed. This reduced the species list to 28 of the 68 species used in most of the TWINSPAN runs. This further reduced species list did not improve the classification, as classification results were essentially the same as with 68 species.

One hundred and eight of the 115 ecology plots were used in the final classification analysis. Seven plots (10, 47, 49, 69, 72, 87, and 114) were removed because they were excessively disturbed. Final analysis through TWINSPAN was made with 108 plots, 68 species, and default values for all program options except pseudospecies cut levels. It may be helpful for future users of TWINSPAN to know that best the results were made with default options (except pseudospecies cut levels), and that the results are likely more subjective and repeatable than if more parameters had been varied from defaults.

Associations

The TWINSPAN analysis was not the end of the classification process. TWINSPAN analysis produced plant groupings (plant associations) that retained borderline and misclassified plots. In other words, there were likely some plots that TWINSPAN classified into the wrong plant association. This was apparent by the fact that in successive TWINSPAN runs with slight modification in pseudospecies cut levels, there were some plots that jumped back and forth between associations. Percent similarity between plots was used to determine within which association these difficult plots would be located. These plots were placed in the plant association that had plots with the highest percent similarity to the plot in question.

After each plot had its proper place in an association, each association was studied in more detail, and comparisons were made among associations. This process was facilitated by a constancy table of the plant associations. Constancy tables illustrate species composition relationships within and between plant associations.

Verification of plant associations

Once the plant associations have been identified through TWINSPAN, a multi-response permutation procedure (MRPP) was used to test the hypothesis of no difference among the groups of plots within the plant associations. MRPP is a "non-parametric procedure for testing the hypothesis of no significant difference among two or more groups of entities" (McCune, 1987). The MRPP procedure used is part of a package of programs called PC-ORD (McCune, 1987). MRPP measures the distances between all pairs of plots within each association, and calculates a within-group average distance. Average distance was obtained using the Euclidean distance measure. Comparisons are made between these within-group averages and all other partitions (possible groupings) of the same number of plots in the same number of groups (Mielke et al., 1981). MRPP does not require data to be normally distributed, or to have equal variances and covariances (McCune, 1987; Mielke et al., 1981). Normality and equal variances are required by many other statistical analyses, but rarely exists in community data.

Procedurally, MRPP requires each plot to be identified to its group, or association. The program then reports if the average between point distance (Euclidian distance) within each group (plant association), and tests the hypothesis of no significant difference among groups (Figure 7).

DIVERSITY

After the plant associations were identified, it was possible to analyze their composition and structure. Some measures of diversity were used to do this analysis. Diversity is defined as: "The relative degree of abundance of (wildlife) species, communities, habitats, or habitat features per unit area" (Thomas, 1979). Management for diversity preserves viable populations of as many species as possible throughout a landscape. Vegetative and habitat diversity relates directly to the availability of ecological niches. Niches are habitats which supply factors necessary for the existence of an organism or species (Hanson, 1962).

Richness and equitability are the two components of heterogeneity, a measure of diversity. Richness equals numbers per unit area. Equitability is evenness in relative abundance of items per unit area (Westman, 1990). Three types of diversity are defined by Whittaker (1972). These are:

1) **Alpha diversity** - The number of species and the evenness of distribution of those species within a single habitat or community. This is micro-scale diversity, generally to be found in the area of a stand, a plot, or community, etc.

2) **Beta diversity** - The extent of differentiation of communities (or associations) along habitat (or environmental) gradients. This is between-community diversity.

3) **Gamma diversity** - A product of the alpha diversity of communities and the degree of beta differentiation among them. This is landscape or macro-diversity.

The terms alpha, beta, and gamma diversity have a broad acceptance in the field of ecology. These terms are used by Whittaker (1972), Moral and Flemming (1979), Noss (1983), and Schroeder (1987). There are two other types of diversity defined by Thomas (1979). These are:

1) **Vertical diversity** - The diversity in an area resulting from the complexity of aboveground vegetation stratification. This could be either on a micro-scale and

associated with alpha diversity or on a macro-scale and associated with beta diversity. Micro-scale vertical diversity can be found, for example, in a forest and takes into account all the various grass, forb, shrub, and tree strata. Macro-scale vertical diversity, for example, can be made up of different stands of different age and size classes spread throughout the landscape (Thomas, 1979).

2) **Horizontal diversity** - This is dispersion (juxtaposition) of vegetation over an area. An example is the various age and size classes of trees over the landscape. Horizontal diversity includes edge. The greater amount of edge, the higher the degree of horizontal diversity (Thomas, 1979).

This study concentrates on alpha and vertical diversity in mature coniferous forests. The Forest as a whole is represented by a wider range of alpha, beta, and gamma (landscape) diversity, which includes many different size classes of coniferous forest stands, hardwood stands, riparian areas, and meadows. Quantifying beta, gamma, and horizontal diversity of McDonald Forest was beyond the scope of this study.

Although there are many measures of diversity, the measures of diversity calculated in this study are species richness, heterogeneity (Shannon's diversity measure), evenness, and vertical structure. Species richness and vertical structure have a number of values affiliated with them for each plant association, whereas heterogeneity (Shannon's diversity measure) and evenness are both single values. All of these measures are calculated as the average of individual plot measures within each plant association.

Species richness was calculated as the number of species that were encountered within each association, and as an average number of species per plot within each association. Average species richness was also calculated for each strata within plant associations. Strata were divided into trees, shrubs, forbs, and grasses. These species richness values are measuring alpha diversity.

Shannon's diversity index is a measure of heterogeneity, involving species richness and equitability. The equation for Shannon's diversity index is:

$$H' = -\Sigma p_i \log p_i$$

where,

$$p_i = n_i / N_i;$$

that is, p_i is the proportion of the total abundance occurring in species i. Logarithmic base 10 was used. Shannon's index was chosen because it best satisfies important criteria according to Elliott (1990). Shannon's diversity index is widely published (Elliott, 1990; Smith, 1980; Schroeder, 1987; and Brower et al., 1990). Evenness is calculated using Shannon's diversity index. It is calculated as the ratio of the observed diversity index value to its maximum value. The evenness equation is:

$$J' = \text{Evenness} = H' / H_{max}'$$

where,

$$H_{max}' = \log s$$

where,

$$s = \text{total number of species}$$

Both of these values, Shannon's diversity index and evenness were calculated using the AID1 program (Overton et al., 1987). The three strata of tree species were added to include only measure for each tree species. Both the heterogeneity and evenness measures are measure of alpha diversity.

Analysis for vertical diversity was limited to the vertical component of vegetation structure. The average percent coverage of each vegetation strata (grass, forb, shrub, and tree strata) was calculated within each association. The tree strata was divided into three categories: >50 feet tall, 12-50 feet tall, and <12 feet tall. The shrub strata was also divided into in three categories: shrubs <2 feet tall, 2-6 feet tall, and >6 feet tall. Average forb and grass percent coverage was also calculated. Vertical profile diagrams were constructed to illustrate vertical structure for five height classes; 0-2, 2-6, 6-12, 12-50, and 50+ feet. Evenness was also calculated using the percent cover of vegetation in each of these five height classes for each association.

Snags were also considered part of the vertical structure of the Forest. Snag composition for the associations and for the plots overall were analyzed. Number, type, and size of snags were recorded on a 150-foot radius plot. Distance to the snag plot boundary was estimated. Three size classes of snags were defined. These were: 4-12" DBH, 12-21" DBH, and 21+" DBH. These size classes were also separated into two types, hardwood and conifer snags. A snag was defined as any dead tree >4" in diameter and 10' tall. The average number of snags/acre in each size class and type was calculated for each association.

An unbalanced analysis of variance and multiple means comparison (Fisher's Protected LSD) was used to identify significant differences in these averages among and between associations for all the measures discussed above. The statistical package SAS, General Linear Models procedure, accomplished this analysis (SAS Institute Inc., 1987).

Snag data were also analyzed independent of associations. Average number of snags per 100 acres in the size and type classes was calculated for the plots overall. Snag availability for some wildlife species on McDonald Forest was also analyzed.

A number of wildlife species that are found in McDonald Forest use snags for nesting, breeding, feeding, and other purposes. Wildlife species on McDonald Forest that use snags were determined from a recent survey in a project titled "Comparisons of Terrestrial Vertebrate Communities and Tree Regeneration Among 3 Silvicultural Systems in the East-Central Coast Range, Oregon" (McComb and Chambers, 1989) (Appendix 6). It was determined that 15 bird and 3 mammal species from this list use snags for breeding, feeding, or resting (Neitro et al., 1985). Appendix 7 lists these species and the suggested size class of snag suitable for nesting for those species that use cavities (Neitro et al., 1985).

Specific snag requirements for six species of woodpeckers on the Forest were calculated by a program called the Snag Recruitment Simulator, or SRS (Marcot, 1989). These species are: downy woodpecker (Picoides pubescens), red-breasted sapsucker (Sphyrapicus ruber), hairy woodpecker (Picoides villosus), northern flicker (Colaptes auratus), red-breasted nuthatch (Sitta canadensis), and the pileated woodpecker (Dryocopus pileatus). SRS calculates the density and size classes of snags required to support populations of these woodpeckers (Marcot, 1989). This program was run to compare snag requirements for these species against the snags that were recorded in this study.

RESULTS

Determination of plant associations on McDonald-Dunn Forest was done through TWINSPAN classification analysis and percentage similarity between plots. These plant association groupings were verified to be significant through a multi-response permutation procedure. Diversity measures; species richness, heterogeneity (Shannon's diversity), evenness, vertical structure, and snag composition results are presented. The associations are described by their location, species composition, and diversity measures. A picture representing a typical plot within each association is also included with plant association descriptions.

CLASSIFICATION

Six plant associations were derived with the aid of TWINSPAN analysis and a percentage similarity matrix for the plots. The complete two-way table for the final TWINSPAN results is in Appendix 8. A simplification of the two-way table for this TWINSPAN run is shown in Table 2.

The species listed in this table (Table 2) are mostly differential species, of which some are indicator species. Acronyms for species names are listed along the left-hand

Table 2. Simplified TWINSPAN classification using differential and indicator species.

Scale for cover percent values in body of table

1= >0-5%	4= 21-30%	7= 51-60%
2= 6-10%	5= 31-40%	8= 61-75%
3= 11-20%	6= 41-50%	9= 76-100%

Table 2.

PLOT NUMBER

SPECIES							SPECIES CLASSIFICATION
	1 1 1 1	1		1	1 1	11111	
	339404 899990 24 989090	855678677011834455554435868	13511171247571	26269 2223391236756803	36687702211	001011	
	129246391246512568539580630	2890605191366858156704325637	19424879715007	0488843460675947831427	52313431235	780912	
BRSY	678691756989863779385955443	111111111211111112111131111	31111111111111	1111111144111111111121111	1111111111	------	0010
RHDI	111118132233132434451423534	453164212433121121213141331	21211131412111	------1-15-11131-11-1-1	-----11-1-1	------	0011
RUUR	1112221 33-233112-11-1113323	35-13322-223252493425853531	22321212213121	111--21111222133211111	22111211111	111111	0011
POMU	123321114112311111111--2211	1423135531132223415324111428	[illegible]	5533312111212132131531	32121213333	344223	010
ACTR	1-1-1---------------------1	-1----1-11-1----------1--21	-1--1-1-11--1-	1221781112111-111211121	1122-1-1111	-1-1--	1101
ANDE	11------------------------1	--11---1-------1-1-1--1-1-1	-----------111	--1--1-11111--11111111	-111-11--11	1--11-	1101
VAHE	11121-------1-------1111111	111---1111-------1----21132	---------2--1-	-31111121111-213244224	13311111111	-11---	1101
VIGL	---------------------------	1--------11------------1---	--1-1-1---1-	34--11-11111121-1112-11	112--1-1---	------	1101
DIHO	--1------------------------	111---1--------------------	-1---------1-	1121111111111-1-1122111	11311111111	------	1110
THOC	----1----------------------	---------------------------	------------1-	112112--11111111123111	1121-1---11	------	1110
BENE	------------------1-1-----1	----------------------1--1	-----1---1--1-	1--913-31-111----1-----	-5-721211-1	223222	1111
ACCI	-----------------------1---	-------2-------------------	--------------	-----1--11------------	5184848--15	243373	1111
GASH	---------------------------	---------------------------	--------------	----------------------	22--4213532	132212	1111
VAPA	---------------------------	---------------------------	--------------	----------------------	-----1---11	111---	1111
COLA	---------------------------	---------------------------	--------------	----------------------	-----------	-11-11	1111
VISE	---------------------------	---------------------------	--------------	----------------------	1----1-1-11	111-11	1111
	000000000000000000000000000	000000000000000000000000000	00000000000000	1111111111111111111111	11111111111	111111	
	000000000000000000000000000	111111111111111111111111111	11111111111111	0000000000000000000000	00000000011	111111	
	000001111111111111111111111	000000000000000000000000000	11111111111111	0000000000000000000000	11111111100	111111	
	000110000000000000000011111	000000000000011111111111111	00000000011111	0000001111111111111111	000000011	000001	
	ABGR/BRSY	ABGR/RUUR-RHDI	ABGR/POMU	ABGR/DIHO-THOC	ABGR/ACCI-GASH	TSHE/ACCI-GASH	

PLOT CLASSIFICATION

margin, and plot numbers along the top of Table 2. The acronym names for the associations are listed at the bottom (Table 2). Full association names and acronym name are listed in Table 3. The values within the chart are categories for species cover values. These categories are defined with the legend (Table 2).

The divisions for the associations were determined through the hierarchy shown along the bottom margins of the two-way table. The hierarchy is depicted in binary notation. The first division in the hierarchy is between plots 70 and 17. The plots on the right-hand side of this division (all 1's) are then divided between plots 22 and 113. The plots on the left-hand side of the first division (all 0's) were at the same time divided between plots 100 and 82. Divisions continued in this fashion. Determinations of plant associations were formed from these hierarchial divisions.

Five plant associations came from the third level of hierarchial divisions, one from the second level. ABGR/BRSY was formed from the second level. Further division of this plant associations was not practical for the intent of this study. Of the five plots that were in the one side of the division that broke off from the main ABGR/BRSY association, one was a misclassified plot, one had 5% cover of BRSY and another 3%. It was felt that the difference of these plots from the main ABGR/BRSY plant association would not be distinguishable on the ground. That the groupings be easily identifiable on the ground was an objective of this study to make it useful to management. The 5 plots that were in this division also did not fit into the environmental gradient by Leavell (1991).

The division between the ABGR/ACCI-GASH and TSHE/ACCI-GASH plant associations does not follow a strict hierarchial division. At the third level of divisions plot numbers 113 and 115 are separated out into their own grouping. A grouping of two plots was not desirable or practical. A comparison of percentage similarity (discussed further below) between these two plots with the plots in both TSHE/ACCI-GASH and ABGR/ACCI-GASH showed that they had higher percent similarity to the plots in the ABGR/ACCI-GASH plant association.

The plots within each plant association are listed in Table 3. The plots listed for each plant association in Table 3 do not match the number of plots for each association in Table 2. Some borderline or misclassified plots were put into a different plant association than shown in Table 2 because they showed higher percentage similarity to the plots in the groupings listed in Table 3 than the plots in the groupings listed in Table 2. For example, plot 46 is in the ABGR/BRSY plant association in Table 2, but is in the ABGR/RUUR-RHDI plant association in Table 3, the final groupings used for this classification. Plot 46 was considered a misclassified plot within the ABGR/BRSY association in the TWINSPAN analysis. Plot 46 had higher percent similarities to the plots in the ABGR/RUUR-RHDI plant association than in the ABGR/BRSY plant association. Plot 46 also looks out of place in the ABGR/BRSY plant association because it has less than five percent cover of *Brachypodium sylvaticum*, whereas the other plots in that association have substantially higher percent cover of this species.

Table 3. Plant associations described on McDonald-Dunn Forest.

PLANT ASSOCIATION	NUMBER OF PLOTS IN ASSOCIATION	PLOTS IN ASSOCIATION
Tsuga heterophylla/Acer circinatum-Gaultheria shallon TSHE/ACCI-GASH	6	107, 108, 109, 110, 111, 112
Abies grandis/Acer circinatum-Gaultheria shallon ABGR/ACCI-GASH	12	21, 22, 28, 35, 62, 63, 73, 74, 81, 103, 113, 115
Abies grandis/Disporum hookeri-Thalictrum occidentale ABGR/DIHO-THOC	21	4, 17, 20, 23, 24, 26, 29, 30, 34, 36, 37, 53, 61, 64, 67, 68, 78, 84, 97, 98, 102
Abies grandis/Polystichum munitum ABGR/POMU	16	7, 11, 12, 14, 18, 19, 27, 39, 41, 50, 54, 65, 70, 71, 75, 77
Abies grandis/Rubus ursinus-Rhus diversiloba ABGR/RUUR-RHDI	27	13, 15, 16, 33, 38, 40, 44, 45, 46, 48, 51, 52, 55, 56, 57, 58, 59, 60, 66, 76, 79, 80, 82, 83, 85, 86, 101
Abies grandis/Brachypodium sylvaticum ABGR/BRSY	26	1, 2, 3, 5, 6, 8, 9, 25, 31, 32, 42, 43, 88, 89, 90, 91, 92, 93, 94, 95, 96, 99, 100, 104, 105, 106

There are one or two indicator species for each of the divisions (plant associations) in the TWINSPAN classification. Indicator species are species indicative of a particular association. Species do not have 100% fidelity to be indicators. Indicators can be species that occur in all plots, but occur at a higher abundance levels (pseudospecies cut levels) in a specific division of the hierarchy. These species have been highlighted in the simplified TWINSPAN run (Table 2). The main indicator species for the ABGR/BRSY plant association is *Brachypodium sylvaticum* (see purple highlight). The indicator species for the ABGR/RUUR-RHDI plant association are *Rubus ursinus* and *Rhus diversiloba* (see orange highlight). These indicator species are the same species by which the plant associations are named. The other four associations are named similarly, by indicator species.

The two-way table also gives a species classification, located along the right margin (Table 2). The species classification is formed through a similar process as the plot classification. Species classification was not used in this study.

A dichotomous key for field identification of associations was made using the indicator species in the TWINSPAN analysis (Figure 6). Instructions on using the key are included at the bottom of the key. This key includes tree species. Tree species are used to identify

Figure 6. Key to plant associations on McDonald-Dunn Forest.

1A.	Western hemlock present and reproducing successfully[1]	**TSHE/ACCI-GASH**
1B.	Western hemlock not present	2
2A.	Vine maple and salal together have >10% coverage, or >30% cover of dwarf Oregon grape	**ABGR/ACCI-GASH**
2B.	Vine maple and salal absent, or only vine maple present with <10% cover	3
3A.	Hooker's fairybells and western meadowrue both present and sword fern <50%, if only one present, then <10% poison oak **and** <30% false brome **and** <50% sword fern	**ABGR/DIHO-THOC**
3B.	Not as above	4
4A.	False brome >10% cover	**ABGR/BRSY**
4B.	False brome not as above	5
5A.	Sword fern >40% cover	**ABGR/POMU**
5B.	Sword fern not as above	**ABGR/RUUR-RHDI**

[1] Tsuga heterophylla is not listed in Table 6, but is used in the key. Even though tree species were not used in the classification, Tsuga heterophylla is the best indicator species for this plant association.

Instructions for key

1. This key is not the classification. Plant association must always be confirmed with written description.
2. User must follow the key from 1A and comply with all conditions as successive steps in the key are followed.
3. It is possible that not every location will key precisely to one plant association. When the key does not work as written, take the route that most closely fits the vegetation, and read descriptions of associations.
4. If area appears to not accurately fit an association, list the association(s) that fits best, or note the reasons why one does not fit. This will aid in future refinement of the classification and/or key.
5. If user gets to the ABGR/RUUR-RHDI plant association by default and the description does not fit, go back through the key and be more flexible using cover standards. If problem persists, read descriptions and find the association that fits best and note as in 4 above.

"series", and shrubs, forbs, or grasses added to define the associations. *Tsuga heterophylla* and *Abies grandis* were found to be the climax tree species on McDonald-Dunn Forest, and name the series of plant associations developed in this study.

Tsuga heterophylla series is identified by the presence of *Tsuga heterophylla* successfully reproducing in an isolated area in the Forest. Most ecology plots had *Abies grandis* present and successfully reproducing, indicating most of the forest (that portion without presence of *Tsuga heterophylla*) belonged in the *Abies grandis* series. A *Pseudotsuga menziesii* plant association was not identified.

The only plant association in the *Tsuga heterophylla* series is *Tsuga heterophylla*/*Acer circinatum*-*Gaultheria shallon*. The other 5 plant associations described here are in the *Abies grandis* series.

Plant associations have been determined to lie on an environmental gradient (Leavell, 1991). The *Tsuga heterophylla*/*Acer circinatum*-*Gaultheria shallon* plant association is at the moist end of the environmental gradient. The *Abies grandis*/*Brachypodium sylvaticum* plant association is on the dry end of the environmental gradient. The other four plant associations are placed between these two associations along the environmental gradient. The list of plant associations (Table 3) is arranged according to this environmental gradient as determined by Leavell (1991).

A Constancy table for associations is found in Table 4. Two numbers are listed for each species and association. The first number is constancy. Constancy is the percentage of plots in the association in which the species occurs. The second number is average percent cover for the plots within the association in which the species occurred. Species are listed alphabetically within four strata: trees, shrubs, forbs, and grasses. Constancy tables were used in describing plant associations, as well as making comparisons of the associations described in this study to other classification studies in western Oregon.

Table 4. Constancy[1] and average percent cover[2] of plants in plant associations on McDonald-Dunn Forest.

Number of Plots	TSHE/ ACCI-GASH N=6	ABGR/ ACCI-GASH N=12	ABGR/DIHO N=21	ABGR/POMU N=16	ABGR/ RUUR-RHDI N=27	ABGR/BRSY N=26
Tree species						
ABGRA[3]	33 / .1	67 / 2.8	76 / 2.5	44 / 2.1	78 / 2.6	85 / 3.3
ABGRB	50 / 3.3	58 / 6.0	67 / 10.8	25 / 2.7	26 / 4.0	50 / 7.1
ABGRC	33 / 3.0	42 / 14.0	43 / 15.0	19 / 4.7	22 / 8.8	15 / 24.8
ACMAA	33 / 0.1	42 / .1	90 / 1.2	100 / 2.1	96 / 4.6	81 / .8
ACMAB	83 / 5.8	33 / 13.7	71 / 11.7	87 / 14.6	81 / 13.5	69 / 9.8
ACMAC	67 / 15.7	58 / 26.9	71 / 34.0	69 / 25.7	55 / 12.4	65 / 27.1
ALRUA						4 / 1.0
ALRUB				6 / 1.0		
ARMEA		8 / .1	5 / 1.0	6 / 4.0	30 / .7	15 / 1.2
ARMEB	17 / 0.5					11 / 1.8
CONUA	17 / 5.0	25 / 1.7	19 / 3.5	44 / 1.7	30 / 1.3	15 / .4
CONUB	67 / 12.7	58 / 6.1	19 / 13.5	19 / 2.0	4 / 2.0	8 / 2.5
FRLAA				12 / 1.5	7 / 1.1	15 / .6
FRLAB			5 / 2.0	6 / 3.0	4 / 2.0	4 / 2.0
FRLAC						4 / 9.0
PRUNUA		8 / .1	5 / .1	6 / 2.0	11 / .4	
PRUNUB		17 / 2.0		12 / 1.0		
PRUNUC				6 / 2.0		
PREMA			5 / .1	19 / .1	7 / .1	19 / .1
PREMB					4 / 2.0	
PREMC					4 / 4.0	
PSMEA	17 / 1.0	58 / .7	28 / 1.5	37 / 1.6	41 / 2.2	35 / 2.3
PSMEB	67 / 8.2	33 / 2.5	24 / 2.4	31 / 3.2	44 / 4.6	61 / 5.7
PSMEC	100 / 40.50	100 / 52.58	100 / 51.6	100 / 56.4	100 / 64.3	100 / 54.8
QUGAA			19 / .1	12 / .5	22 / .6	50 / .5
QUGAB		8 / .5	5 / .5		7 / 2.0	35 / 3.2
QUGAC		8 / 2.0	14 / 1.7	6 / .1	4 / 35.0	46 / 10.3
TABRA	17 / .5	8 / 2.0	14 / .7	6 / .5		
TABRB	83 / 5.8	42 / 5.2	9 / 6.0			4 / 3.0
TABRC	17 / 6.0					
THPLA	17 / .5			6 / 8.0		
THPLB	17 / 2.0			6 / 10.0		
THPLC	33 / 6.0					
TSHEA	67 / 1.8					
TSHEB	67 / 6.7					
TSHEC	67 / 32.2					
Shrub species						
ACCI	100 / 23.8	75 / 39.8	14 / 1.7		4 / 6.0	4 / 3.0
AMAL		17 / .3	9 / 1.6	37 / .2	30 / .1	38 / .8
BEAQ		17 / 1.2	24 / 9.0	19 / .2	41 / .6	15 / .3
BENE	100 / 8.5	75 / 22.1	43 / 4.3	19 / .5	11 / .8	8 / .5
COCO	50 / 3.0	100 / 15.3	100 / 12.0	94 / 11.0	96 / 13.7	100 / 7.5
GASH	100 / 7.8	75 / 15.6				
HODI	50 / 2.4	92 / 3.9	71 / 2.4	44 / 2.1	67 / 3.3	31 / 1.3
LOCI		25 / .2	43 / .3	31 / .2	11 / 1.4	19 / .1
LOHI	17 / .1	25 / 1.3	24 / 1.2	56 / 1.1	67 / 2.3	69 / 1.0

[1] Constancy: the percent of plots in which the species occurred.
[2] Coverage: average cover for those plots in which the species occurred.
[3] The A, B, and C following the acronym names stand for the different tree strata: A = Regeneration (>12' tall), B = midstory (12-50' tall), and C = overstory (50+' tall).

Table 4. (cont.)

Number of Plots	TSHE/ ACCI-GASH N=6	ABGR/ ACCI-GASH N=12	ABGR/DIHO N=21	ABGR/POMU N=16	ABGR/ RUUR-RHDI N=27	ABGR/BRSY N=26
Shrub species (cont.)						
RHPU		33 / .7	33 / .4	69 / .4	67 / .5	50 / .2
RHDI		33 / 1.4	57 / 5.8	100 / 6.4	100 / 15.0	100 / 14.6
RIDI				12 / .3	7 / .3	
ROSA	100 / 1.4	100 / 3.00	100 / 2.8	75 / .9	89 / 1.6	92 / 1.1
RULA			5 / .1	19 / .4	14 / .4	27 / .3
RULE			14 / .2	25 / 1.3	48 / 2.0	8 / 3.5
RUPA	67 / .2	83 / 3.3	71 / 2.1	50 / 1.5	25 / 2.8	31 / .5
RUPR				19 / 1.3	19 / 3.4	8 / 2.8
RUUR	100 / .5	100 / 3.2	90 / 5.3	100 / 7.9	92 / 21.0	88 / 7.0
SAGL	17 / .1	8 / 4.0			4 / 3.0	
SYAL	50 / .1	83 / 5.0	90 / 5.7	87 / 5.9	96 / 5.9	88 / 3.3
SYMO			5 / 25.0	25 / 1.1		15 / .8
VAPA	50 / 1.0	25 / .4				
Forb species						
POMU	100 / 18.3	100 / 10.5	100 / 14.2	100 / 57.2	100 / 12.8	92 / 6.1
PTAQ		50 / 2.7	71 / 3.0	44 / 3.1	74 / 3.2	58 / 4.5
ACTR	33 / .3	83 / 4.2	100 / 9.1	44 / 2.4	26 / 1.5	15 / 1.2
ACRU		33 / 1.8	43 / 5.7	6 / .1		11 / 2.7
ADBI		83 / 1.3	100 / 3.6	100 / 1.8	100 / 2.0	81 / 2.8
ANDE	50 / .1	58 / .8	76 / .9	25 / .1	30 / .1	11 / .4
ARMA		58 / .6	81 / 2.1	37 / 1.7	52 / 2.9	19 / .3
ASCA	17 / .1	8 / .1	5 / 5.0			
CASC	17 / .1	100 / .8	76 / .8	31 / 1.7	33 / .7	27 / .3
COLA	67 / .5					
DIFO		17 / .1	9 / .3	25 / 2.3	11 / 4.2	4 / .1
DIHO		100 / 2.2	95 / 2.7	19 / .9	11 / 1.5	4 / .1
FRVE	17 / .1	25 / .1	48 / .6	56 / .6	67 / 1.5	46 / .4
GAAP		33 / .8	24 / .2	31 / .3	30 / .8	
GATR	67 / .2	92 / 1.1	90 / 1.6	100 / 1.9	100 / 3.6	92 / 1.1
GOOB		50 / .1	62 / .2	50 / .3	63 / .3	58 / .3
HIAL		42 / .3	43 / .3	50 / .3	37 / .2	35 / .1
HYOC			24 / 1.6	19 / .1	11 / .7	
IRTE				6 / .1	4 / 2.0	
LAMU			19 / .9	37 / 4.3	33 / 4.6	19 / 1.6
LATHY		17 / .3	57 / .6	31 / .1	26 / .2	19 / .3
LIAP		17 / 1.5	38 / 2.4	25 / 2.0	37 / 1.7	35 / 1.4
MOSI	17 / .1	25 / .2	57 / 2.5	75 / 2.2	55 / 1.4	15 / .3
NEPA			24 / .1	31 / .1	7 / .1	
OSCH	17 / .1	83 / 1.3	100 / 2.1	100 / 2.4	100 / 3.7	92 / 1.6
PRVU				6 / .1	4 / .1	15 / .2
SACR				19 / .4	7 / .1	8 / .1
SADO		25 / 1.0	33 / 2.1	69 / 1.1	78 / 2.9	61 / 2.0
SEJA		25 / .1	5 / .5	19 / .1	33 / .2	11 / .1
SMRA	50 / .1	42 / .3	19 / .3	12 / .3	7 / .3	4 / .1
SMST	17 / .1	33 / 2.5	43 / 3.6	19 / 1.7	22 / 2.0	8 / .5
STCR				19 / .4	18 / .3	4 / .1
SYRE		25 / .7	52 / .9		22 / 1.2	8 / .8
TEGR	17 / .1	17 / .6	43 / 1.2	56 / .8	26 / .2	4 / .1
THOC		67 / 2.1	90 / 3.3	6 / .5	4 / .5	4 / .1
TRLA	83 / .4	100 / 2.4	90 / 2.0	69 / 1.8	78 / 2.7	31 / 1.2

Table 4. (cont.)

Number of Plots	TSHE/ ACCI-GASH N=6	ABGR/ ACCI-GASH N=12	ABGR/DIHO N=21	ABGR/POMU N=16	ABGR/ RUUR-RHDI N=27	ABGR/BRSY N=26
Forb species (cont.)						
TROV	33 / .1	67 / .1	57 / .1	50 / .1	15 / .1	4 / .1
VAHE	33 / .8	100 / 3.6	90 / 10.0	25 / 3.0	41 / 4.0	50 / 2.5
VECAC		50 / .2	28 / .2			
VICIA		8 / .1		6 / .1	7 / .1	
VIGL		42 / 3.0	81 / 4.4	25 / 1.6	18 / 3.6	
VISE	83 / .2	42 / .5				
Grass species (and grasslike species)						
BRSY		100 / 1.6	100 / 4.6	100 / 2.2	100 / 3.3	100 / 53.3
BRVU		8 / .1			4 / .5	11 / .2
CAREX	33 / .1	33 / .4	14 / .7	19 / .9	33 / .6	4 / .1
FEOC		67 / .6	57 / .5	31 / .7	30 / 1.2	15 / .2

VERIFICATION OF ASSOCIATIONS

Multi-response permutation procedure (MRPP) results are illustrated in Figure 7. Each plant association is reported as a group with an average distance. Each distance represents a within-group average of pairwise distance measures (Zimmerman et al., 1985). MRPP results demonstrated significant differences (alpha < .05) among the groupings of plots (associations).

The average distance for the TSHE/ACCI-GASH association (group 6) is 25.4. This is the smallest average distance among the six associations. This shows that the TSHE/ACCI-GASH plots are more similar to each other than the plots within the other associations.

Figure 7. MRPP output for six plant associations.

```
            MULTI-RESPONSE PERMUTATION PROCEDURES (MRPP)

INPUT HAS  108 plots
THERE WERE  68 species
WEIGHTING OPTION:    C(I) = n(I)/sum(n(I))
DISTANCE MEASURE = Euclidean


GROUP NUMBER  1 OF SIZE  26 HAS AN AVERAGE DISTANCE =  39.437039
     (ABGR/BRSY)

GROUP NUMBER  2 OF SIZE  21 HAS AN AVERAGE DISTANCE =  48.375329
     (ABGR/DIHO-THOC)

GROUP NUMBER  3 OF SIZE  16 HAS AN AVERAGE DISTANCE =  34.103703
     (ABGR/POMU)

GROUP NUMBER  4 OF SIZE  27 HAS AN AVERAGE DISTANCE =  42.853919
     (ABGR/RUUR-RHDI)

GROUP NUMBER  5 OF SIZE  12 HAS AN AVERAGE DISTANCE =  62.215145
     (ABGR/ACCI-GASH)

GROUP NUMBER  6 OF SIZE   6 HAS AN AVERAGE DISTANCE =  25.433365
     (TSHE/ACCI-GASH)


THE TEST STATISTIC IS =      -39.184033
THE OBSERVED DELTA IS =       42.992055
THE EXPECTED DELTA IS =       60.220312
THE VARIANCE OF DELTA =       .19331449
THE SKEWNESS OF DELTA =      -.72922439

PROBABILITY OF A SMALLER OR EQUAL DELTA =     .00000000
```

DIVERSITY

SPECIES RICHNESS

Total species richness values for associations as well as average per plot species richness by strata (tree, shrub, forb, grass) within each association are presented (Table 5). The six plant associations defined in this study differ significantly[2] in species richness values.

Total species richness is lowest for the TSHE/ACCI-GASH plant association which has a total of 38 species. The other plant associations have higher, similar total species richness values that range from 63 to 70 species.

The two associations on either end of the environmental gradient (Leavell, 1991), TSHE/ACCI-GASH and ABGR/BRSY, have the lowest average per plot species richness values (21.7 and 24.4). These two association values are significantly different from the other four associations which have higher and similar species richness values of 33.2 (ABGR/ACCI-GASH), 34.0 (ABGR/DIHO-THOC), and 30.2 (for both ABGR/POMU and ABGR/RHDI-RUUR).

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[2] Throughout this section "significant" differences refers to alpha = .05.

Table 5. Species richness by plant association and strata.

Plant Association	# of plots in association	Total Species Richness in Association	Average Species Richness/plot[1] in association	Ave. Tree Richness/ plot	Ave. Shrub Richness/ plot	Ave. Forb Richness/ plot	Ave. Grass Richness/ plot
TSHE/ACCI-GASH	6	38	21.7 C[3] (2.28)[2]	5.5 A (0.76)	8.0 B (1.15)	7.8 C (8.60)	.3 C (0.236)
ABGR/ACCI-GASH	12	63	33.2 AB (5.32)	3.9 B (1.61)	9.7 A (2.39)	17.7 B (2.63)	2.1 A (0.759)
ABGR/DIHO-THOC	21	65	34.0 A (3.75)	3.7 B (0.891)	8.0 B 1.57)	20.2 A (2.52)	1.7 AB (0.69)
ABGR/POMU	16	70	30.2 B (5.61)	4.0 B (0.94)	9.1 AB (1.98)	15.5 B (4.02)	1.6 AB (0.61)
ABGR/RHDI-RUUR	27	69	30.2 B (4.13)	4.0 B (1.17)	9.4 AB (1.57)	15.1 B (3.84)	1.7 AB (0.67)
ABGR/BRSY	26	64	24.4 C (5.28)	4.4 B (1.18)	8.3 AB (1.99)	10.2 C (3.93)	1.4 B (0.68)

[1] All average species richness values are means calculated from the plots within the association.

[2] All values in parentheses are standard deviations.

[3] Within each column, means with the same letter are not significantly different (P = 0.05, GLM, multiple means comparison, unbalanced ANOVA, Fisher's Protected LSD).

Species richness within tree, shrub, and grass strata are fairly similar between associations. One plant association, TSHE/ACCI-GASH, had 5.5 tree species/plot. This is significantly higher than the other plant associations.

The shrub richness was higher in the ABGR/ACCI-GASH plant association is than in the TSHE/ACCI-GASH and ABGR/DIHO-THOC plant associations.

The TSHE/ACCI-GASH association had the lowest species richness in the grass strata, with 0.3 species/plot for an association average. This is significantly lower than the other five plant associations. The other associations had grass species richness values of 1.4 to 2.1 species/plot.

The most significant difference in species richness among associations was within the forbaceous strata (F = 70.8, p = .0001). The ABGR/DIHO-THOC plant association had the highest forbaceous species richness, 20.2 species/plot. This was significantly higher from all other associations. ABGR/ACCI-GASH, ABGR/POMU, and ABGR/RUUR-RHDI plant associations had the next highest average forbaceous species richness per plot values (17.7, 15.5, 15.1). The TSHE/ACCI-GASH and ABGR/BRSY plant associations had the lowest forbaceous species richness with 7.8 and 10.2 forbaceous species/plot.

DIVERSITY AND EVENNESS

Shannon's diversity index and an evenness measure were calculated for each plant association (Table 6). Shannon's diversity is significantly higher in the ABGR/ACCI-GASH, ABGR/DIHO-THOC, and ABGR/RUUR-RHDI plant associations. Evenness was shown to be significantly lower for the ABGR/POMU and the ABGR/BRSY plant associations.

VERTICAL STRUCTURE

Vertical structure, giving average percent cover by strata for each association, is shown in Table 7. There were no significant differences in percent cover in any tree strata among associations. There were significant differences among associations in cover percent of the shrub, forb, and grass strata. The dominance of percent cover in certain strata support characterizing associations as shrub, forb, or grass types.

Table 6. Shannon's diversity[1] and an evenness[2] measure.

Association	N=	Diversity[1] mean (SD)		Evenness[2] mean (SD)	
TSHE/ACCI-GASH	6	.868 (.090)[3]	B[4]	.650 (.067)	A
ABGR/ACCI-GASH	12	.995 (.110)	A	.656 (.067)	A
ABGR/DIHO-THOC	21	1.020 (.078)	A	.670 (.055)	A
ABGR/POMU	16	.869 (.117)	B	.592 (.066)	B
ABGR/RUUR-RHDI	27	.966 (.092)	A	.651 (.054)	A
ABGR/BRSY	26	.827 (.103)	B	.601 (.065)	B

[1] Shannon's diversity index - measure of heterogeneity. Calculated as average for plots within association.
[2] Evenness using Shannon's diversity index - averages for plots within association.
[3] Standard deviation for averages (means).
[4] Within each column, means with the same letter are not significantly different (P = 0.05, GLM, multiple means comparison, unbalanced ANOVA, LSD).

Table 7. Vertical structure: percent cover by strata.

Association	Trees[3] >50'	Trees 12-50'	Trees <12'	Shrubs total	Shrubs <2'	Shrubs 2-6'	Shrubs >6'	Forb	Grass
TSHE/ACCI-GASH	75.2[1] (11.1)[2]	26.7 (9.0)	1.7 (1.3)	43.3 BC[4] (15.7)	17.2 C (3.7)	5.2 B (4.5)	24.3 B (16.1)	19.3 D (8.6)	.2 B (.2)
ABGR/ACCI-GASH	68.5 (16.5)	17.0 (14.3)	2.9 (2.9)	73.3 A (19.8)	37.5 A (24.4)	20.2 A (14.1)	39.9 A (24.0)	27.1 CD (14.2)	2.3 B (1.7)
ABGR/DIHO-THOC	75.7 (11.8)	18.4 (16.2)	3.8 (2.4)	34.5 C (21.5)	16.2 C (15.1)	9.6 B (7.4)	12.0 C (11.1)	55.5 B (21.5)	4.9 B (7.5)
ABGR/PDMU	73.4 (16.9)	16.0 (19.1)	5.1 (2.8)	31.2 C (16.3)	15.4 C (6.8)	7.7 B (5.2)	8.8 C (10.1)	71.1 A (15.9)	2.7 B (3.5)
ABGR/RUUR-RHDI	73.7 (12.7)	15.8 (19.1)	6.9 (6.1)	55.6 B (24.1)	33.6 AB (19.9)	10.6 B (9.1)	13.9 C (11.5)	33.3 C (14.1)	4.0 B (4.0)
ABGR/BRSY	76.3 (9.2)	14.7 (10.7)	5.4 (5.2)	34.0 C (17.0)	22.7 BC (12.4)	5.1 B (4.9)	7.2 C (6.0)	16.1 D (10.4)	54.7 A (22.5)

[1] All values are average percent cover calculated using values from each plot within the association.

[2] All values in parentheses are standard deviations.

[3] There were no significant differences between associations in the Tree strata.

[4] Within each column, means with the same letter are not significantly different (P = 0.05, GLM, multiple means comparison, unbalanced ANOVA, Fisher's Protected LSD).

The ABGR/ACCI-GASH plant associations had the highest shrub cover percent 73.3. TSHE/ACCI-GASH and ABGR/RUUR-RHDI plant associations were the next highest in shrub percent cover (55.6 and 43.3 percent). Three associations; ABGR/ACCI-GASH, ABGR/RUUR-RHDI, and TSHE/ACCI-GASH are characterized as shrub types, as they have greater percent cover of shrubs than any other understory strata.

The ABGR/POMU plant association had the highest percent cover of forbs (71.1 %). The next highest was ABGR/DIHO-THOC with 55.5 percent cover forbs. The forb strata was the most dominant understory strata for these two associations. These associations were characterized as forbaceous types. The next highest percent cover of forbs was in the ABGR/ACCI-GASH and ABGR/RUUR-RHDI plant associations with 33.3 and 27.1 percent cover. The TSHE/ACCI-GASH and ABGR/BRSY plant associations had the lowest cover of forbs (19.3 and 16.1).

The ABGR/BRSY association had the highest percent cover in the grass strata, with 54.7 percent. This was significantly higher than all other associations. The ABGR/BRSY association was characterized as a grass type as the grass strata had the highest percent cover of the understory strata within this association.

A vertical profile and its affiliated evenness value for each association is illustrated in Table 8. Vertical profiles were made on the basis of 5 vertical strata categories: 0-2', 2-6', 6-12', 12-50', and 50+'. It is evident from these figures that ABGR/ACCI-GASH and ABGR/RUUR-RHDI have the highest percent cover in the tall shrub category (6-12 feet). ABGR/POMU has the highest percent coverage in the forb strata (0-2 feet), followed by ABGR/BRSY and ABGR/DIHO-THOC. The TSHE/ACCI-GASH association has the least amount of cover in the 0-6 foot strata. ABGR/ACCI-GASH has the highest total percent cover of all strata combined. TSHE/ACCI-GASH has the lowest total persent cover of all strata. The ABGR/ACCI-GASH plant association has the highest evenness of .914. ABGR/POMU and ABGR/BRSY have the lowest evenness values, .771 and .734 respectively.

Figure 8. Vertical profiles for plant associations.

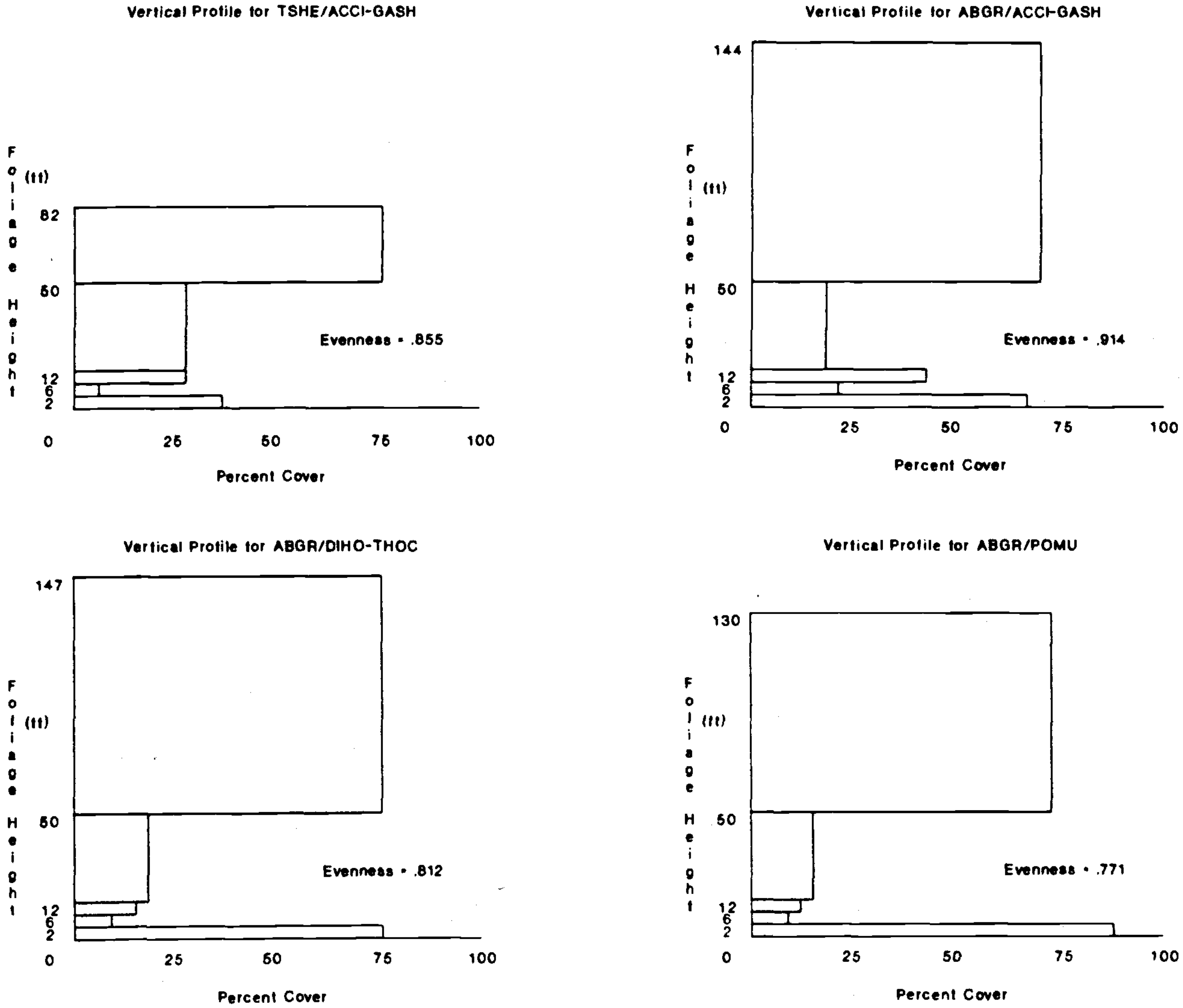
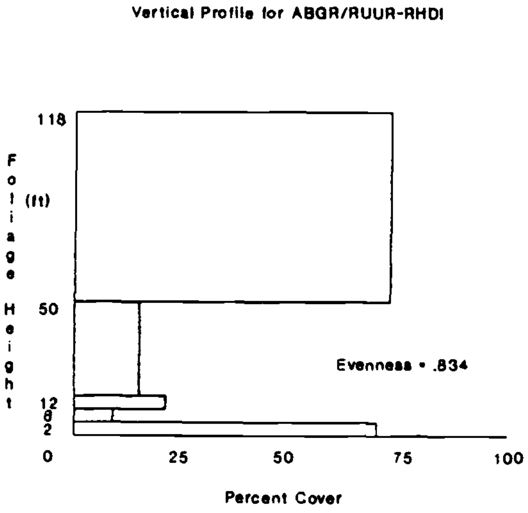
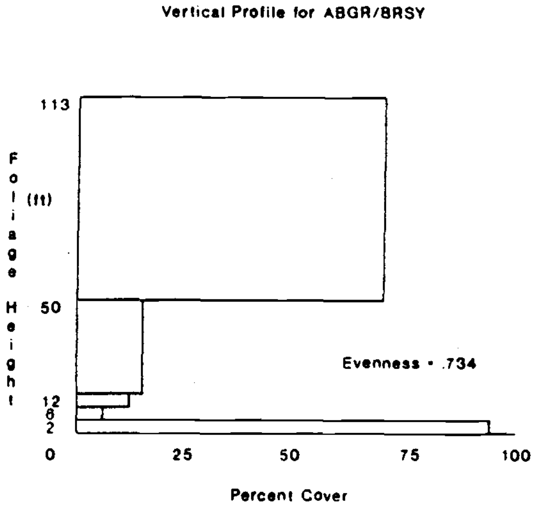


Figure 8. (cont.)





<u>Snags</u>

Snag information for each plant association is summarized in Table 9. Average number of snags per plot within each association are listed. There were no significant differences in average number of snags between associations at the level tested (alpha=.05). In spite of no significant differences between plant associations, snag inventory results revealed the size and type of snags found within McDonald-Dunn Forest. Eighty-seven percent (8.1/acre) of the snags were in the 4 to 12-inch class, 11 percent (1.1/acre) in the 12 to 21-inch class, and 1.5 percent (0.2/acre) in the 21+-inch class. Most snags were in the smallest diameter class.

The proportion of hardwood to conifer snags was fairly equal in the 4 to 12-inch class; 45% and 42% of total snags respectively. The 12 to 21-inch class had a higher percentage of hardwood snags; 9% versus 2% of total snags respectively. The 21+-inch class contains the least snags; .5% hardwood and 1% conifer of the total snags sampled. Snags are also listed by snags per 100 acres in each size class (Table 9). There were 810 snags per 100 acres in the 4 to 12-inch size class, 100 in the 12 to 21-inch size class, and 14 in the 21+-inch size class. These values are used for comparison to snags required for populations levels calculated by the Snag Recruitment Simulator

(Marcot, 1989). The results from the Snag Recruitment Simulator (Marcot, 1989) are in Table 10. This table lists six species of primary cavity-nesters found on the Forest, and the number and size of snags that are required for different species populations levels. Analysis through SRS (Snag Recruitment Simulator, Marcot, 1989) indicated that a total of 383 snags would be needed to support 100% populations of theses six species of cavity-nesters (Table 10). The size of snags necessary to support 100 percent populations were: 16 snags 11+ inches, 237 snags 15+ inches, 124 snags 17+ inches, and 6 snags 25+ inches in diameter per 100 acres. Snags necessary to support 90 to 30% population levels are also listed. Comparisons of these levels to the current snag composition on McDonald Forest can be found in the discussion section of this study.

Table 9. Snag summary for ecology plots on McDonald-Dunn Forest.

Association	Ave. # snags per acre	4-12" DBH HW	4-12" DBH CON	12-21" DBH HW	12-21" DBH CON	21+" DBH HW	21+" DBH CON
TSHE/ACCI-GASH	6.0 (3.83)[1]	.9	3.5	.4	.4	0	.7
ABGR/ACCI-GASH	3.8 (2.37)	1.2	1.1	.6	.3	0	.7
ABGR/DIHO-THOC	7.9 (5.26)	3.5	2.7	1.2	.4	0	0
ABGR/POMU	6.9 (7.29)	2.2	4.4	.5	0	0	0
ABGR/RHDI-RUUR	16.7 (25.5)	9.0	4.8	.6	.1	.1	0
ABGR/BRSY	13.1 (8.44)	4.9	6.7	1.4	.3	.1	0
Total # of snags in category		782	728	157	41	8	23
Percent of snags in category		45%	42%	9%	2%	.5%	1%
# of snags/acre in category		4.2	3.9	.8	.2	.04	1.5
# of snags per 100 acres in size class[2]		810		100		14	

[1] values in parentheses are standard deviations - 95% conf.
[2] calculations based on a total of 1739 sampled snags

Table 10. Number and size of snags required for selected cavity-nesters.

Species	Snag Diameter Class[1] (inches)	Number of snags required per 100 acres for percentage of population size[2]								
		Population size								
		100	90	80	70	60	50	40	30	20
downy woodpecker	11+	16	14	13	11	10	8	6	5	3
red-breasted sapsucker	15+	45	41	36	32	27	23	18	14	9
hairy woodpecker	15+	192	173	154	134	115	96	77	58	38
northern flicker	17+	48	43	38	34	29	24	19	14	10
red-breasted nuthatch	17+	76	69	61	53	46	38	31	23	15
pileated woodpecker	25+	6	5	5	4	4	3	2	2	1
Total snags		383	345	307	268	231	192	153	116	76

[1] Snag diameter class as defined by Neitro(1985).

[2] Percent of population size values from Marcot (1989). Percent of population is the population level at which you want to manage the species (Marcot, 1989).

PLANT ASSOCIATION DESCRIPTIONS

Coniferous tree species composition is fairly similar throughout the plant associations except for the Tsuga heterophylla/Acer circinatum-Gaultheria shallon plant association. For this reason, tree species composition will be described briefly here and individual plant association descriptions will focus on understory shrub, forb, and grass species.

The most consistent component of the coniferous overstory is Pseudotsuga menziesii; it occurs with 100 percent constancy (Table 4). Abies grandis is the next most frequently encountered conifer species in the overstory. These two species dominate the overstory in all plant associations described in this study. The Tsuga heterophylla/Acer circinatum-Gaultheria shallon plant association is unique in the addition of Tsuga heterophylla as a component in the overstory. Taxus brevifolia can be found occasionally throughout much of the forest, but occurs most frequently in the Tsuga heterophylla/Acer circinatum-Gaultheria shallon plant association. Thuja plicata was encountered in the Tsuga heterophylla/Acer circinatum-Gaultheria shallon and the Abies grandis/Polystichum munitum plant associations.

Acer macrophyllum dominates the deciduous tree species component within the plant associations, and is found throughout the Forest. Acer macrophyllum often dominates the midstory strata in the Forest (12 to 50 foot class). The next most consistent deciduous tree species found in the Forest are Cornus nuttallii and Quercus garryana. Quercus garryana was encountered most often in and is a fairly consistent component of the Abies grandis/Brachypodium sylvaticum plant association. Other hardwoods that can be found occasionally in the plant associations are Prunus spp, Fraxinus latifolia, Arbutus menziesii. Alnus rubra was encountered on only one plot within this study. Understory tree species composition generally follows the trends of the overstory tree species, but is more variable.

Descriptions of the six plant associations classified in this study for the McDonald-Dunn Forest follow. The associations are described in the order in which they are placed along the environmental gradient (Leavell, 1991), moist to dry. The geographic range where an association was encountered are given by Tract. Tracts are maps for geographic areas within the Forest, each Tract is on a separate Forest map. There are 8 Tracts within McDonald-Dunn Forest. Tract locations are outlined in Appendix 9.

Tsuga heterophylla/Acer circinatum-Gaultheria shallon

Western hemlock/vine maple-salal

TSHE/ACCI-GASH

Figure 8. _Tsuga heterophylla/Acer circinatum-Gaultheria shallon_ plant association.

This plant association is very limited geographically. It occurs in only one drainage located in the Soap Creek Tract, and is scattered over an area of less than one square mile. The plant association is located within the west half of Sec. 6, T11S.R5W., Willamette Meridian.

The TSHE/ACCI-GASH association is characterized by the presence of _Tsuga heterophylla_ as well as shrub species _Acer circinatum_, _Gaultheria shallon_, and _Berberis nervosa_. _Tsuga heterophylla_ was not encountered in any other area on the McDonald-Dunn Forest, and has not been found anywhere else by Forest workers. The TSHE/ACCI-GASH association is characterized as a shrub-dominated association, with an average of 44.3% cover in the shrub strata (Table 9). The association has low cover in the forb and grass strata (19.3 and 0.2% respectively).

The TSHE/ACCI-GASH association is low in species richness as compared to the other associations on McDonald-Dunn Forest. There were a total of 38 different species encountered in the plots making up this association. The highest number of species in an association on this Forest is 70 (ABGR/POMU) (Table 5). This plant association and ABGR/BRSY have the lowest total richness among associations, 21.7 and 24.4 species per plot respectively. The TSHE/ACCI-GASH association has the highest species richness in the tree strata. This plant association is in the upper half of the range for evenness and in the lower half of the range for Shannon's diversity for associations (Table 6).

Species found in this plant association but not in other associations described for McDonald-Dunn are <u>Tsuga heterophylla</u> and <u>Coptis laciniata</u>. <u>Taxus brevifolia</u>, <u>Acer circinatum</u>, <u>Gaultheria shallon</u>, <u>Vaccinium parviflorum</u>, and <u>Viola sempervirens</u>, are generally limited to the TSHE/ACCI-GASH and the ABGR/ACCI-GASH plant associations. These species are all indicative of moist sites in this area (Leavell, 1991).

This association is also characterized by the absence of the following species: Brachypodium sylvaticum, Rhus diversiloba, Rhamnus purshiana, Adenocaulon bicolor, Goodyera oblongifolia, Disporum hookeri, and Thalictrum occidentale. Even though these species were not located within this association, they are nearly ubiquitous throughout the rest of the Forest.

Stands that are within this association have the most recent intensive disturbance history of all stands sampled. Stands within this association were 35-40 years old, the youngest of identified plant associations. This area was clearcut in 1946 (approximately 50 MBF/acre were removed), and was slash burned in 1949 (Rowley, 1989). Part of the area was planted with 2-0 Douglas-fir in 1959 with 8' X 8' spacing. Other parts of this area were allowed to naturally regenerate. Even though this area has been very disturbed, it has an identifiably unique association in which Tsuga heterophylla is an indicator species.

The TSHE/ACCI-GASH association is on the moist end of the environmental gradient (Leavell, 1991). A combination of environmental factors including elevation, solar radiation, soils, and aspect make this geographical location the most moist part of the McDonald-Dunn Forest (Leavell, 1991).

Abies grandis/Acer circinatum-Gaultheria shallon

Grand fir/vine maple-salal

ABGR/ACCI-GASH

Figure 9. Abies grandis/Acer circinatum-Gaultheria shallon plant association.

The ABGR/ACCI-GASH plant association is also limited in extent. This plant association geographically surrounds the TSHE/ACCI-GASH association. It is just out of the range where Tsuga heterophylla can exist, or has migrated. This association can also be found south of the Lewisberg saddle area, and in the northern part of the Forest in the bottom of the South Fork of Berry Creek tract.

ABGR/ACCI-GASH is characterized by the presence of Acer circinatum, Gaultheria shallon, and Berberis nervosa. The main floristic difference between the ABGR/ACCI-GASH association and TSHE/ACCI-GASH is the lack of *Tsuga heterophylla*. The ABGR/ACCI-GASH association is shrub-dominated, with an average of 73.3% cover in the shrub strata. This is the highest shrub cover among associations. Forb and grass cover is comparatively low (21.7 and 2.3% respectively).

This is a species rich association. There is an average of 33.2 species per plot within the association, which is similar to all but the TSHE/ACCI-GASH and the ABGR/BRSY plant associations which have 21.7 and 24.4 species per plot respectively. The ABGR/ACCI-GASH association is in the upper half of the range for both evenness and Shannon's diversity among associations.

This association has a presence of the following species that are absent in the TSHE/ACCI-GASH association: *Brachypodium sylvaticum*, *Rubus ursinus*, *Adenocaulon bicolor*, *Disporum hookeri*, and *Thalictrum occidentale*. *Rhus diversiloba* and *Rubus ursinus* were also found in low abundance. ABGR/ACCI-GASH has the highest coverage of *Corylus cornuta* of any of the associations. *Achlys triphylla* and *Vancouveria hexandra* are generally found in this association.

The ABGR/ACCI-GASH association is on the moist end of the environmental gradient, having moist site indicators such as *Acer circinatum* and *Gaultheria shallon* (Leavell, 1991). Stands in the ABGR/ACCI-GASH association are some of the oldest stands on the Forest, with an average stand age of 129 years. Many of the old-growth stands on the Forest are within this plant association.

Abies grandis/Disporum hookeri-Thalictrum occidentale

Grand fir/hooker's fairybells-western meadowrue

ABGR/DIHO-THOC

Figure 10. Abies grandis/Disporum hookeri-Thalictrum occidentale plant association.

The ABGR/DIHO-THOC plant association is more widespread geographically than the TSHE/ACCI-GASH and ABGR/ACCI-GASH associations. It occurs throughout the Forest where preferred environmental conditions exist. This association occurs primarily in the Oak Creek and Jackson Creek tracts, but is also found to a limited extent in Peavy and Forest Peak Ridge Road tracts.

The ABGR/DIHO-THOC type is characterized by the presence of both Disporum hookeri and Thalictrum occidentale. Berberis nervosa is present and dominates the understory within approximately half of the ecology plots in this association. Most forbs occurring in this type also occur in the ABGR/ACCI-GASH association. Viola glabella, Vancouveria hexandra, Anemone deltoidea, Campanula scouleri, and Achlys triphylla are also commonly present in this association. The ABGR/DIHO-THOC association is forb-dominated. It has an average of 55.5% cover in the forb strata. The only association with higher forb percent is ABGR/POMU, with 77.1% cover. The ABGR/DIHO-THOC association is relatively low in both shrub and grass cover (34.5 and 4.9% cover respectively).

This is a species rich association. There were 65 species encountered within this plant association. ABGR/DIHO-THOC and ABGR/ACCI-GASH have the highest average species richness per plot among associations (34.0 and 33.2 species per plot). The ABGR/DIHO-THOC association also has the highest forb species richness associations, with 20.2 forbs per plot. This plant association is in the high half of the range for both evenness and Shannon's diversity between associations.

Species on the dry end of the gradient such as Ribes divaricatum, Rubus discolor, Stellaria crispa, and Sanicula crassicaulis (Leavell, 1991) are absent within this association. Species on the moist end of the gradient such as Viola sempervirens, Coptis laciniata, Vaccinium parviflorum, Gaultheria shallon, and Tsuga heterophylla are also absent. Acer circinatum occurs only occasionally in this association. The ABGR/DIHO-THOC association is located towards the moist end of the environmental gradient, but is drier than the TSHE/ACCI-GASH and ABGR/ACCI-GASH associations (Leavell, 1991).

Abies grandis/Polystichum munitum

Grand fir/sword fern

ABGR/POMU

Figure 11. Abies grandis/Polystichum munitum plant association.

This association occurs throughout the Forest, and was found in all tracts except Soap Creek.

The ABGR/POMU association is characterized by a high percentage cover (generally >40%) of Polystichum munitum. Rhus diversiloba, Rubus ursinus, and Corylus cornuta are a consistent component of this association, but generally have less than 10% cover each. ABGR/POMU is a forb-dominated association. It has an average of 71.1% cover in the forb strata, the majority of which is Polystichum munitum. This is a significantly higher percent forb cover than all other associations on McDonald-Dunn Forest. This association has low cover of shrubs and grasses (31.2 and 2.7% respectively).

This association is also species rich. A total of 70 species were encountered within the association, which is the highest among associations. But it has an average of 30.2 species per plot within the association which is significantly higher than the TSHE/ACCI-GASH and ABGR/BRSY plant associations. This plant association in similar in species richness per plot to ABGR/ACCI-GASH and ABGR/RUUR-RHDI. This association is in the lower half of the range for both evenness and Shannon's diversity between associations.

Besides the dominance of Polystichum munitum, a number of forb species are occasionally present in low abundance. These are: Thalictrum occidentale, Disporum hookeri, Vancouveria hexandra, Actaea rubra, and Smilacina stellata. Species on the moist end of the gradient such as Viola sempervirens, Coptis laciniata, Vaccinium parviflorum, Gaultheria shallon, and Tsuga heterophylla are absent. The species on the dry end of the gradient, such as Ribes divaricatum, Rubus discolor, Stellaria crispa, and Sanicula crassicaulis (Leavell, 1991) are occasionally present in low abundance in this association. The ABGR/POMU association is mesic on the environmental gradient for the Forest (Leavell, 1991).

Abies Grandis/Rubus ursinus-Rhus diversiloba

Grand fir/trailing blackberry-poison oak

ABGR/RUUR-RHDI

Figure 12. Abies grandis/Rubus ursinus-Rhus diversiloba plant association.

The ABGR/RUUR-RHDI association was found throughout the Forest except in the Soap Creek tract. This and the ABGR/BRSY associations are the most common plant associations encountered in this study.

ABGR/RUUR-RHDI is characterized by a high coverage of Rhus diversiloba and Rubus ursinus and generally <5% coverage of Brachypodium sylvaticum. This association lacks the high cover of Polystichum munitum, which occurs consistently in the ABGR/POMU association. ABGR/RUUR-RHDI is a shrub-dominated association. It has an average of

55.6% cover of shrubs. The only other association with a higher cover in the shrub strata is ABGR/ACCI-GASH, with 73.3% cover. The shrub cover of this associations is similar to the TSHE/ACCI-GASH plant association, both are higher in shrub cover than the ABGR/DIHO-THOC, ABGR/POMU, and ABGR/BRSY plant associations.

This association is also species rich. A total of 69 species were encountered within the plots. There is an average of 30.2 species per plot, which is in the middle of the range of species per plot among plant associations. This plant association is in the upper half of the range for both evenness and Shannon's diversity between associations.

Dry-site species such as Rubus discolor, Stellaria crispa, and Sanicula crassicaulis, Rubus leucodermis, Lactuca muralis, and Senecio jacobaea can occur in this association. Many species on the moist end of the environmental gradient such as Viola sempervirens, Coptis laciniata, Vaccinium parviflorum, Gaultheria shallon, Thalictrum occidentale, and Tsuga heterophylla are absent. Acer circinatum and Disporum hookeri are other moist-site indicators that occur occasionally in this association.

The ABGR/RHDI-RUUR association occurs in the mesic to dry environments in the Forest (Leavell, 1991). Both Rhus diversiloba and Rubus ursinus, which are indicator species, are located towards the dry end of the species environmental gradient (Leavell, 1991).

Abies grandis/Brachypodium sylvaticum

Grand fir/false brome

ABGR/BRSY

Figure 13. Abies grandis/Brachypodium sylvaticum plant association.

The ABGR/BRSY association was found mostly in the southern third of McDonald-Dunn Forest, in the Oak Creek and Jackson Creek tracts. Brachypodium sylvaticum occurs throughout the Forest, except in the TSHE/ACCI-GASH association. Eighty-nine out of 115 ecology plots have Brachypodium sylvaticum. But, coverages are mostly low outside of the ABGR/BRSY plant association.

The ABGR/BRSY association and is characterized by a high coverage (>40%) of Brachypodium sylvaticum. Brachypodium sylvaticum is a well-established understory dominant within portions of McDonald-Dunn Forest. However, it is not indigenous to this area (Hubbard, 1954). This species is not a transitory part of the community. It appears to be spreading and increasing in dominance in parts of the Forest (Leavell and Hubbard, 1989).

ABGR/BRSY is a grass-dominated association. It has an average of 54.7% cover of grass (53.3% Brachypodium sylvaticum), which is the highest among plant associations. Cover of shrubs and forbs is relatively low (34.0 and 16.1% respectively).

A total of 64 species were encountered within the association, which makes it moderate in total species richness. But, the ABGR/BRSY association has an average of 24.4 species per plot, sharing the spot of lowest species richness per plot with the TSHE/ACCI-GASH plant association. Forb species richness in this association is relatively low (10.2 species per plot). This plant associations is in the lower half of the range for both evenness and Shannon's diversity between associations.

ABGR/BRSY association often has a component of mature Quercus garryana, but is not limited to stands with evidence of Oak remnants. The most common shrubs in this type are Rhus diversiloba, Rubus ursinus, and Corylus cornuta. Coverage of Polystichum munitum is considerably less (generally <10%) compared to the ABGR/RUUR-RHDI or ABGR/POMU associations.

The ABGR/BRSY association is on the dry end of the environmental gradient for the plant associations in McDonald Forest (Leavell, 1991).

DISCUSSION

CLASSIFICATION

SERIES DETERMINATION

Two series were identified in McDonald-Dunn Forest, Tsuga heterophylla, and Abies grandis. A Pseudotsuga menziesii series was considered, but not supported by the data in this study.

The Tsuga heterophylla series is identified by the presence of Tsuga heterophylla being present and successfully reproducing in an isolated area on the Forest. Tsuga heterophylla is the most shade tolerant tree species on this Forest, and therefore the climax tree species where it is present and reproducing successfully.

In the areas where Tsuga heterophylla was not present, Abies grandis was determined to be the climax tree species (less shade tolerant than Tsuga heterophylla, but more shade tolerant than Pseudotsuga menziesii). Most ecology plots had Abies grandis present and successfully reproducing, indicating most of the forest (that portion without the presence of Tsuga heterophylla) belonged in the Abies grandis series.

Twenty-three plots did not contain presence of Tsuga heterophylla or Abies grandis, and could have potentially been in a Pseudotsuga menziesii series. Even though Pseudotsuga menziesii is the dominant tree species in the stands sampled, a Pseudotsuga menziesii series was not identified. Series for the plant associations are identified by the potential climax coniferous tree species (conifers are the dominant life form in the stands sampled). Pseudotsuga menziesss is not considered a potential climax species in the portion of the McDonald-Dunn Forest sampled in this study.

The plots without Tsuga heterophylla or Abies grandis (plot numbers 8, 11, 12, 13, 22, 28, 35, 44, 61, 63, 65, 70, 71, 77, 85, 86, 91, 92, 98, 107, 110, 114) would have been the plots conducive to a Pseudotsuga menziesii series. These plots should have clustered at the dry end of the environmental gradient for the classification if Pseudotsuga menziesii was to be a climax species on the Forest, just as the plots in the Tsuga heterophylla series were clustered at the moist end of the environmental gradient. TWINSPAN analysis failed to cluster these plots into an association(s) independent of plots with presence of Tsuga heterophylla or Abies grandis. These plots were scattered throughout the classification, failing to cluster at any point. This trend occurred whether or not tree species were included in the analysis. The following hypotheses were posed:

1) These plots are part of the Abies grandis series, or

2) The classification is not based on an environmental gradient, or

3) All plots, except the Tsuga heterophylla plots, are in a Pseudotsuga menziesii series, or

4) The classification procedure does not work.

The first hypothesis is preferred. The plots without Tsuga heterophylla or Abies grandis are part of the Abies grandis series. Tree species have been managed in this Forest for a substantial period of time as indicated by an earlier discussion of the thinning that has occurred in the stands sampled in this study. The presence of Abies grandis could have been affected by management. Although Abies grandis was not found in every plot, it is hypothesized that it could grow on the entire Forest. Therefore the plots mentioned above are in the Abies grandis series.

The other hypotheses appear to be less feasible. The second hypothesis was eliminated by the work of Leavell. Leavell (1991) has determined an environmental gradient does exist for the associations in this classification.

It is doubtful that the third hypothesis is viable since Abies grandis is more shade tolerant than Pseudotsuga menziesii which makes Abies grandis the more likely climax species. Abies grandis and it is abundant and reproducing successfully (where allowed) in the majority of the Forest. Also, if a Pseudotsuga menziesii series did exist, it should be in the driest areas within the Forest. But the most southern, lowest elevation sites in the forest have abundant Abies grandis regeneration as well as Pseudotsuga menziesii. Abies grandis appears to be climax in these areas.

That the classification procedure does not work does not appear to be a valid hypothesis. The procedures used for this classification, mainly TWINSPAN, are being used and promoted by many ecologists in the Pacific Northwest (Hemstrom, 1990; Smith, 1990; Halpern, 1990; Atzet, 1990). Also, the results of this classification, the plant associations, appear to match what is visible and interpretable on the ground. Time will be needed to prove or disprove this hypothesis.

COMPARISONS

Existing classifications and plant association/community descriptions for western Oregon were studied in detail to find parallels to the associations described for McDonald-Dunn Forest. Of the six plant associations described on McDonald-Dunn Forest, only one, the ABGR/ACCI-GASH, adequately matched a previous description. The association that matched ABGR/ACCI-GASH came from Juday (1976); his old-growth Pseudotsuga menziesii-Acer circinatum/Corylus cornuta-Adenocaulon bicolor association in the Valley-Margin Zone of the Oregon Coast Range. There was no precedent for the descriptions of the other five plant associations. The TSHE/ACCI-GASH, ABGR/DIHO-THOC, ABGR/POMU, ABGR/RUUR-RHDI, and ABGR/BRSY plant associations described in this study appear to not have been previously described. This section will compare the plant associations on McDonald-Dunn Forest to existing classifications and community descriptions.

Juday (1976) described a Pseudotsuga menziesii-Acer circinatum/Corylus cornuta-Adenocaulon bicolor association (PSME-ACCI/COCO-ADBI) in the Valley-Margin Zone of the Coast Range that floristically matches the ABGR/ACCI-GASH plant association on the McDonald-Dunn Forest. According to Juday (1976) this association is "the most widespread and abundant community in the Valley-Margin Zone." Minor differences exist between these two associations: Acer circinatum and Corylus cornuta have more coverage, and POMU has less coverage in ABGR/ACCI-GASH than in Judays' PSME-ACCI/COCO-ADBI association. There are also some minor forbaceous species that occur in trace amounts in Judays' association that are missing in ABGR/ACCI-GASH. This could be because Juday sampled over a larger area, the entire Valley-Margin Zone (Figure 4), and was doing a classification based on old-growth stands. To define and describe the associations on McDonald-Dunn as succinctly as possible, the plant association name, ABGR/ACCI-GASH will be retained. It is desirable mainly because Abies grandis, not Pseudotsuga menziesii, is considered the climax tree species.

There were no parallels found for the floristic composition of the TSHE/ACCI-GASH plant association described on McDonald-Dunn. However, there were other classifications that described a TSHE/ACCI-GASH association, but their floristic compositions were different from the TSHE/ACCI-GASH plant association described for McDonald-Dunn Forest. Juday (1976) described a TSHE/ACCI-GASH plant association in his old-growth study in the Coast Range, and Hemstrom and Logan (1986) described TSHE/ACCI-GASH plant association in the Siuslaw National Forest.

The TSHE/ACCI-GASH plant association described by Judy (1976) did not contain Abies grandis which is common in the McDonald-Dunn TSHE/ACCI-GASH association. Alnus rubra, Oxalis oregana are species in Juday's description that are not found in the TSHE/ACCI-GASH association on McDonald-Dunn. The total species richness for the TSHE/ACCI-GASH association on McDonald Forest was 38 species, whereas there were a total of 56 species found in Juday's association. There are other plant associations described by Juday that show some similarities to the TSHE/ACCI-GASH association. They are:

Pseudotsuga menziesii-(Tsuga heterophylla)/Corylus cornuta, Tsuga heterophylla-Pseudotsuga menziesii/Acer circinatum/Polystichum munitum, and Tsuga heterophylla/Polystichum munitum. These associations are missing species such as Abies grandis or Acer macrophyllum, and have other species not found in TSHE/ACCI-GASH in McDonald Forest such as Oxalis oregana, Oploplanax horridum, Rubus ursinus, Bromus vulgaris.

The TSHE/ACCI-GASH plant association described by Hemstrom and Logan (1986) for the Siuslaw National Forest also has a different floristic composition from the TSHE/ACCI-GASH association on McDonald Forest. Hemstrom and Logan's TSHE/ACCI-GASH association contain Alnus rubra, Picea sitchensis, Sambucus racemosa, Oxalis oregana, Vaccinium ovatum, Athyrium felix-femina and Blechnum spicant which are not in the TSHE/ACCI-GASH association in McDonald Forest. Abies grandis is also missing from Hemstrom and Logan's description. Abies grandis is a consistent component of the TSHE/ACCI-GASH plant association in McDonald Forest. The TSHE/ACCI-GASH plant association on McDonald-Dunn Forest is not like the other TSHE/ACCI-GASH plant associations described elsewhere (Hemstrom and Logan, 1986; Juday, 1976).

It must be kept in mind that there are some problems in the plots from McDonald Forest for the TSHE/ACCI-GASH association. First the stands averaged only 35-40 years old. Stands this young are generally found to have less species diversity because the tight canopy inhibits the full expression of understory vegetation. Many classification schemes would have avoided stands at this stage of development. These plots were retained within this classification as they identify a unique plant association for which more mature stands were unavailable. Second, there were only 6 plots from which to describe this association. A sample size this small is likely to underestimate the total number of species found in the association. More plots within the Tsuga heterophylla area in McDonald Forest were not available.

There were no parallel descriptions for the other four plant associations described on McDonald Forest. The following is a discussion of other classifications in the western Oregon, Coast and Cascade Ranges, which were studied for communities with floristic similarity to those found on McDonald Forest. Comparisons are made to Pseudotsuga menziesii associations throughout, even though none were identified on McDonald-Dunn Forest because some Pseudotsuga menziesii associations in these other studies may contain Abies grandis. Associations were chosen for comparison if:

1) it was possible to key plots on McDonald-Dunn Forest to them, or

2) if their plant association or community name contained species occurring on McDonald-Dunn Forest.

Other associations described by Juday (1976) in the Valley-Margin Zone were compared to Abies grandis associations on McDonald Forest (Table 11). These associations do not fit the Abies grandis associations on the Forest as they do not contain Rhus diversiloba, Rubus parviflorus, Rubus ursinus, or Quercus garryana.

Table 11. Association from Juday (1976) that were reviewed for similarity to McDonald-Dunn plant associations.

Valley-Margin Zone
Pseudotsuga menziesii-Acer macrophyllum/Corylus cornuta v. californica/Bromus vulgaris
Pseudotsuga menziesii/Holodiscus discolor
Pseudotsuga menziesii-Thuja plicata/Gaultheria shallon/Linnaea borealis

Merkle (1948) described four communities on Marys Peak in the Oregon Coast Range. Marys Peak is located approximately 12-15 miles to the southwest of McDonald-Dunn Forest. Merkle's communities (1948) were defined as north slope, east slope, south slope, and meadow communities. These communities were found to be different from the associations described on McDonald-Dunn Forest as all four communities contained Oxalis oregana, and three contained Abies procera. The Marys Peak area is substantially higher in elevation from McDonald-Dunn Forest as all four communities lie above 2,500 feet, and Marys Peak itself is at 4097 feet. Ecology plots taken on McDonald-Dunn Forest range from 340 to 1,520 feet.

Anderson (1967) described six plant communities in the Marys Peak watershed that were reviewed for similarity to McDonald-Dunn Forest plant associations (Table 12).

Table 12. Plant communities from Anderson (1967) that were reviewed for similarity to McDonald-Dunn plant associations.

Corylus californica/Bromus vulgaris
Acer circinatum/Gaultheria shallon (Corylus californica-Holodiscus discolor subtype
Holodiscus discolor/Gaultheria shallon
Acer circinatum/Polystichum munitum

The Holodiscus discolor/Gaultheria shallon, and Acer circinatum/Polystichum munitum communities are dissimilar to all McDonald-Dunn Forest associations because these two communities do not contain Abies grandis. Although the other two associations, Corylus californica/Bromus vulgaris and Acer circinatum/Gaultheria shallon (Corylus californica-Holodiscus discolor subtype) have species composition somewhat similar to the McDonald-Dunn Forest TSHE/ACCI-GASH and ABGR/ACCI-GASH associations, they contain a substantial amount of Bromus vulgaris which is not found in TSHE/ACCI-GASH, and is rare in ABGR//ACCI-GASH. Tsuga heterophylla is also lacking from these associations.

Bailey (1966) described five associations in the Southern Oregon Coast Range on the Millicom Tree Farm. There were only two of these that were compared for similarity to McDonald-Dunn Forest associations, an Acer circinatum/Berberis nervosa and a Holodiscus discolor/Gaultheria shallon association. These two associations are unlike those on McDonald-Dunn as they do not contain Abies grandis, and contain either Oxalis oregana which is absent in McDonald-Dunn Forest associations, or Bromus vulgaris, which is scarce.

The Siuslaw National Forest plant association and management guide (Hemstrom and Logan, 1986) contains six plant association descriptions for Tsuga heterophylla that were reviewed for to the McDonald-Dunn TSHE/ACCI-GASH plant association (Table 13). The TSHE/ACCI-GASH association was already compared above. There were no Abies grandis plant associations described on the Siuslaw National Forest (Hemstrom and Logan, 1986). Abies grandis was not mentioned within these associations. Therefore comparisons were made with only the TSHE/ACCI-GASH plant association on McDonald-Dunn Forest. All of the comparable associations described by Hemstrom and Logan (Table 13) have the following dissimilarities to the TSHE/ACCI-GASH association. They all contain Alnus rubra, Picea sitchensis, Sambucus racemosa, Oxalis oregana, Vaccinium ovatum, Athyrium felix-femina and Blechnum spicant which

Table 13. Plant associations in the Siuslaw National Forest (Hemstrom and Logan, 1986) reviewed for similarity to McDonald-Dunn Forest plant associations.

Tsuga heterophylla/Berberis nervosa
Tsuga heterophylla/Berberis nervosa-Gaultheria shallon
Tsuga heterophylla/Gaultheria shallon
Tsuga heterophylla/Polystichum munitum
Tsuga heterophylla/Acer circinatum-Gaultheria shallon
Tsuga heterophylla/Acer circinatum-Polystichum munitum

are not in the TSHE/ACCI-GASH association in McDonald Forest. Abies grandis is also missing from Hemstrom and Logan's descriptions.

Thilenius (1968) described four communities in a study of the Quercus garryana forests of the Willamette Valley (Table 14). These communities are different from the associations on McDonald-Dunn Forest. They contain a number of species that were not found in this study such as Philadelphus lewisii, Torilis arvensis, Cynosurus echinatus, Holcus lanatus and Poa pratensis. Proportions of species were also quite different, as many stands had Quercus garryana as the dominant in the tree layer, and species such as Galium spp, Dactylis glomerata, and Torilis arvensis as dominants in the forbaceous layer. But these communities contain Rhus diversiloba in significant quantities, and also many other species that are found in McDonald-Dunn Forest. No other classifications reviewed had communities or associations with a high cover of Rhus

Table 14. The Quercus garryana communities of the Willamette Valley (Thilenius, 1968).

Quercus garryana/Corylus cornuta/Polystichum munitum
Quercus garryana/Prunus avium/Symphoricarpos albus
Quercus garryana/Amelanchier alnifolia/Symphoricarpos albus
Quercus garryana/Rhus diversiloba

diversiloba. Precipitation in the area Thilenius (1968) studied is approximately 40 inches. This is likely the lower limit of precipitation for McDonald-Dunn Forest. These Quercus forests are therefore drier than those on McDonald-Dunn, whereas most of the classifications studies reviewed are in areas of higher precipitation. The striking similarity of Thilenius' descriptions is in the high abundance of Rhus diversiloba which is not found in many other studies.

The plant association and management guide for the Willamette National Forest in the Cascade Range (Hemstrom et al., 1987) is one of two classifications reviewed that describes Abies grandis associations. Abies grandis associations are also found in Topik et al. (1988). The Willamette National Forest guide has Pseudotsuga menziesii, Abies grandis, and Tsuga heterophylla associations that were reviewed for similarity to McDonald-Dunn Forest plant associations (Table 15).

All of the Pseudotsuga menziesii associations, except for Pseudotsuga menziesii/Symphoricarpos mollis, contain pines (Pinus lambertiana, Pinus ponderosa, or Pinus monticola), which the associations on McDonald-Dunn Forest do not contain. Castinopsis chrysophylla, and Whipplea modesta are in all five of the Pseudotsuga menziesii associations, which are also absent in McDonald-Dunn associations. The Abies grandis/Berberis nervosa

Table 15. Plant associations on the Willamette National Forest (Hemstrom et al., 1987) reviewed for similarity to associations on McDonald-Dunn Forest.

Pseudotsuga menziesii/Holodiscus discolor-Berberis nervosa
Pseudotsuga menziesii/Holodiscus discolor/grass
Pseudotsuga menziesii/Symphoricarpos mollis
Pseudotsuga menziesii-Tsuga heterophylla/Berberis nervosa
Pseudotsuga menziesii-Tsuga heterophylla/Gaultheria shallon
Abies grandis/Berberis nervosa
Tsuga heterophylla/Berberis nervosa
Tsuga heterophylla/Berberis nervosa/Gaultheria shallon
Tsuga heterophylla/Berberis nervosa/achlys triphlla
Tsuga heterophylla/Gaultheria shallon
Tsuga heterophylla/Polystichum munitum
Tsuga heterophylla/achlys triphlla

association described by Hemstrom et al. (1987) also contains pines (Pinus lambertiana and Pinus ponderosa) which are absent in McDonald-Dunn Forest associations. The Abies grandis association also contains Tsuga heterophylla, which excludes it from an Abies grandis association on McDonald-Dunn Forest.

The five Tsuga heterophylla associations by Hemstrom et al. (1987) have combinations of Pinus lambertiana, Pinus ponderosa, Pinus monticola, Calocedrus decurrens, Rhododendron macrophyllum, Chimaphila umbellata, Vaccinium alaskaense, Whipplea modesta, Oxalis oregana, and Xerophyllum tenax, all of which do not occur on the TSHE/ACCI-GASH association on the McDonald-Dunn Forest.

The plant association and management guide for the Western Hemlock Zone on the Mt. Hood National Forest (Halverson, et al., 1986) contains seven plant associations that were reviewed for similarity to the TSHE/ACCI-GASH plant association on McDonald-Dunn Forest (Table 16). As all these associations contain Tsuga heterophylla, they are compared only to the TSHE/ACCI-GASH association on McDonald-Dunn Forest. These associations contain combinations of Abies amabilis, Abies procera, Alnus rubra, Castanopsis chrysophylla, Rhus diversiloba, Rhododendron macrophyllum, Vaccinium alaskaense, Oxalis oregana, Xerophyllum tenax, and Oploplanax horridum. All of these species are absent in the TSHE/ACCI-GASH association on McDonald-Dunn Forest.

Dyrness et al. (1974) did a preliminary classification of forest communities in the central portion of the western Cascades. They described six plant associations that I compared for similarity to associations on McDonald-Dunn Forest (Table 17). These six plant associations described

Table 16. Plant associations in the Western Hemlock Zone on the Mt. Hood National Forest (Halverson et al., 1986) reviewed for similarity to McDonald-Dunn plant associations.

Tsuga heterophylla/_Acer circinatum_/_achlys triphlla_
Tsuga heterophylla/_achlys triphlla_
Tsuga heterophylla/_Berberis nervosa_
Tsuga heterophylla/_Berberis nervosa_-_Gaultheria shallon_-MTH*
Tsuga heterophylla/_Berberis nervosa_/_Polystichum munitum_
Tsuga heterophylla-_Pseudotsuga menziesii_/_Holodiscus discolor_
Tsuga heterophylla/_Polystichum munitum_-MTH*

* MTH stands for associations that use the same name elsewhere in the Pacific Northwest, but are not identical to those described in Mt. Hood National Forest (Halverson et al., 1986).

by Dyrness et al. (1974), contain _Tsuga heterophylla_, and were therefore comparable to the TSHE/ACCI-GASH plant association on McDonald-Dunn Forest. These associations were unlike TSHE/ACCI-GASH as most contain _Castanopsis chrysophylla_, _Rhododendron macrophyllum_, and _Whipplea modesta_, which do not occur in the TSHE/ACCI-GASH association on McDonald-Dunn Forest. These associations also lack _Abies grandis_, except for the _Pseudotsuga menziesii_/_Acer circinatum_-_Berberis nervosa_ association that has only a trace of percent cover. All of McDonald-Dunn plant associations contain _Abies grandis_.

A study was done on the dry coniferous forests in the western Cascades (Means, 1980). Means (1980) described two communities that I reviewed for similarity to plant associations on McDonald-Dunn Forest. These are:

Table 17. Plant associations in the central portion of the western Cascades (Dyrness et al., 1974) reviewed for similarity to plant associations on McDonald-Dunn Forest.

Pseudotsuga menziesii/Holodiscus discolor
Pseudotsuga menziesii-Tsuga heterophylla/Corylus cornuta
Pseudotsuga menziesii/Acer circinatum/Gaultheria shallon
Pseudotsuga menziesii/Acer circinatum/Berberis nervosa
Tsuga heterophylla/Acer circinatum/Polystichum munitum
Tsuga heterophylla/Polystichum munitum

Pseudotsuga menziesii/Holodiscus discolor/Acer circinatum, and Pseudotsuga menziesii/Berberis aquifolium/Disporum. The PSME/HODI/ACCI community does not contain Abies grandis, which all McDonald-Dunn plant associations contain. Also, most plots from which the community type was described contain either Castinopsis chrysophylla, Libocedrus decurrens, or Pinus lambertiana, which do not occur in McDonald-Dunn plant associations. Since Tsuga heterophylla is absent from the PSME/BEAQ/Disporum community type, it was comparable only to the Abies grandis plant associations on McDonald-Dunn Forest. Only two out of nine plots used to describe this community have Abies grandis, and with only 0.1 and 1% cover. This cover percent was too low to match a McDonald-Dunn Forest association. There was also insufficient cover of Rhus diversiloba, Polystichum munitum, Rubus ursinus, and no Brachypodium sylvaticum, which was necessary to match most McDonald-Dunn Forest plant associations.

The plant association and management guide for the ponderosa pine, Douglas-fir, and grand fir zones in the Mt. Hood National Forest (Topik et al., 1988) describes plant associations that are on the east side of the Cascade Range. These associations contain Pinus ponderosa, Larix occidentalis, Pinus contorta, Picea engelmannii, or Pinus monticola, all of which are absent in McDonald-Dunn Forest (except some species that are planted). This classification is not comparable to the classification developed for McDonald-Dunn Forest.

I conclude that five of the plant associations described for McDonald-Dunn do not fit associations in other classifications. These five plant associations are different because the vegetation composition and structure is distinct in some way from these other classifications. Namely, the presence of Abies grandis and the lack of species indicating a moister environment than McDonald-Dunn. Adjacent forests on the eastern flanks of the Oregon Coast Range could reasonably be expected to contain plant communities similar to the ones that have distinguished the plant associations on McDonald-Dunn.

DIVERSITY

Diversity is important to managers because it provides a baseline of alpha and vertical diversity from which they can make decisions. Managers can use the baseline diversity levels to measure the effects of their management on diversity. Some activities may increase diversity, while others may decrease it. Managers can choose which aspects of diversity they are interested in and have measures for comparing and evaluating the effects of management upon diversity. Although the stands sampled for this study are representative of the most mature communities available on the Forest at this time, they are still seral stands. This baseline data necessarily represents the diversity of plant associations derived from seral stands and not climax stands. Therefore, the data provides a baseline of information for the mature forests of McDonald-Dunn at this point in time.

SPECIES RICHNESS, SHANNON'S DIVERSITY, AND EVENNESS

Species richness, Shannon's diversity, and evenness values can provide Forest managers with some insight into diversity of the mature stands in the Forest. For instance, of the six plant associations identified, two are lower in average species richness per plot than the rest (Table 5, page 65), the TSHE/ACCI-GASH and ABGR/BRSY plant associations. There is an explanation why these associations are low in species richness.

The TSHE/ACCI-GASH plant association had the lowest per plot species richness (21.7 ave. species/plot) likely because of the stage of development of the stands sampled within this plant association. Stands sampled for the TSHE/ACCI-GASH association had an average age of 34 years, which indicates these stands are in an early successional stage. This and the fact that there are only 6 plots (small sample size) representing this plant association means that species richness could be underestimated. This plant association also has only been located in a geographically limited area, which also may also related to low species richness. Species diversity could increase as stands in this association develop towards climax. It should be interesting to measure species richness in these stands 50 years from now.

The explanation is somewhat different for the low per plot species richness of the ABGR/BRSY plant association. The stands sampled in this plant association are more developed successionally than TSHE/ACCI-GASH, although they are still seral. Low per plot species richness in ABGR/BRSY is more than likely related to the tough competition afforded by Brachypodium sylvaticum, the dominant understory vegetation. Brachypodium sylvaticum averaged 55.5% cover on plots within the association (Table 7, page 69). Note that the total species richness for this association, 64 species, is very similar to total species richness of the other associations (except TSHE/ACCI-GASH) which range from 63 to 70. Sixty-four is not a low total species richness value. Yet average species richness per plot is significantly lower than these other associations. This indicates that a variety of species are still found within this plant association, but that they are fewer and farther in between, possibly being slowly pushed out of the community by competition with Brachypodium sylvaticum.

The ABGR/BRSY association has a low value for Shannon's diversity and evenness between associations (Table 6, page 69). The species composition is skewed by the predominance of Brachypodium sylvaticum. This would not be considered a problem if Brachypodium sylvaticum was a desirable species. But, it is not a desirable species. It also is not indigenous to the Forest. It is an invader that has persisted and spread. It is not palatable as forage (Hubbard, 1954), and provides competition to indigenous species, likely including conifer regeneration. This species also appears to be spreading in it's range on the Forest (Leavell and Hubbard, 1989).

Evenness is low, on a relative scale, for the ABGR/POMU plant association, which has it's understory dominated by Polystichum munitum. This association is high in species richness, with 70 species total species within the association. Yet the low evenness signifies that there are fewer of many species and more dominance shown by a few species. Polystichum munitum is likely providing competition for other species within this association.

The lower species diversity found in the ABGR/BRSY or the ABGR/POMU plant associations is not inherently less desirable than that found in other plant associations. But it would not be desirable to have the entire Forest have their characteristics, as is true with any of the plant associations. At this point in time the mature stands of McDonald-Dunn Forest do have a range of diversity. It would be desirable to continue to have that range of diversity on the Forest. The range of diversity that these plant associations represent (in species richness, Shannon's diversity, evenness, and structural diversity) create part of the between community, or beta, diversity of the Forest.

It is also important to recognize that the stands sampled in this study represent only a part of the Forest, and therefore only a part of the diversity. There were a total of 117 species identified within this study, but 339 species were identified by Hall and Alaback (1982) in their survey of the Forest's species, and 227 were identified by West (1964). The Forest as a whole has higher species richness. Where are those species? Likely in riparian areas, meadows, microsites, hardwood stands, and roadsides that were not sampled in this study. These species richness comparisons highlight the fact that a significant amount of the species richness lies in areas other than the mature stands that were sampled. Therefore, areas such as riparian areas, meadows, microsites, and hardwood stands are important in maintaining the species diversity of McDonald-Dunn Forest.

Species richness values were characterized by data taken at one point in time. If stands sampled were in an undisturbed climax state, then the species richness would be representative of climax communities. The species richness values do not represent that of undisturbed climax communities. It is the intention of this study to be able to identify these same plant associations in the future. But changes in composition and structure may change over time, which may affect the associations.

The species richness values mentioned represent a part of alpha diversity, or within community diversity. Species richness of most plant associations of McDonald Forest is comparable to species richness found in climax communities in other classification studies. TSHE/ACCI-GASH is the one plant association on McDonald Forest that is substantially lower than the other associations on McDonald Forest as well as lower than associations in other classifications. It's has a total of 38 species in the association, whereas the other associations on McDonald Forest are represented by 63 to 70 species. Associations reviewed by Juday have total species richness values of 41 to 66 species. The associations studied on the Siuslaw National Forest (Hemstrom and Logan, 1986) are represented by 54 to 61 species. The communities described by Anderson (1967) had approximately 36 to 49 total species within the communities. Plant associations studied on the Willamette National Forest (Hemstrom et al., 1987) showed total species richness values of 59 to 90 for the associations reviewed. This high number of species in the Willamette National Forest is reasonable as it has a larger beta diversity representing a wider range of environments. From these ranges we can see that although total species richness is the lowest in the TSHE/ACCI-GASH plant association on McDonald Forest, at least one other association by Anderson (1967) has been shown to have even fewer species. These figures also show that the species richness of these associations on McDonald Forest is as high and in some cases higher than that of associations in surrounding areas.

In most associations (this study and others reviewed), species richness is highest in the forb strata. Associations that are lower in species richness usually appear to have similar numbers of species in the tree and shrub strata. The variation in forb species richness more strongly determining the total species richness of the associations.

The plant associations described on McDonald-Dunn Forest also add to the gamma, or landscape, diversity of the Coast Range. These associations are on the dry end of the environmental gradient for the Coast Range, being robbed of Coastal moisture by the mountains to the west. Drier site species such as Abies grandis, Quercus garryana, Amelanchier alnifolia, Rubus laciniatus, Rubus leucodermis, Arenaria macrophyllum, and Galium aparine were not even mentioned in the Siuslaw National Forest plant association guide (Hemstrom, 1986). These and other species not present in the surrounding area increase the species richness on the landscape level.

VERTICAL STRUCTURE

Different plant associations have concentrations of cover in different vertical strata of vegetation (aside from the tree strata which is high in cover in all associations). The TSHE/ACCI-GASH, ABGR/ACCI-GASH, and ABGR/RUUR-RHDI have their understory dominated by shrub cover (Table 7, page 69). ABGR/POMU and ABGR/DIHO-THOC are dominated by forbs, and ABGR/BRSY is dominated by grass. Having concentrations vegetation in different strata of vegetation in the plant associations increases the structural diversity of the Forest.

The percent cover in the tree strata is fairly consistent between plant associations. Percent cover in the >50' tree class ranges from 68.5 to 76.3 for the associations (no significant difference). The lack of variation in percent cover within the mature tree strata (>50 feet) was due, in part, to past thinning practices. Tree crowns have been opened up fairly uniformly by thinning practices (Rowley, 1990) in many of the stands sampled. The stands are also fairly similar aged (except TSHE/ACCI-GASH) Pseudotusga menziesii and Abies grandis forests.

Only a part of the range of structural diversity of this Forest is represented by the plant associations in this study. This study concentrates on within (alpha) structural diversity, whereas the Forest as a whole is represented by a much wider range of landscape (gamma) structural diversity. There are many different size and age classes of coniferous forest stands, as well as hardwood stands, riparian areas, and meadows that are integral to structural diversity on the landscape level. Quantifying landscape diversity was beyond the scope of this study.

Snags

Snag quality and distribution are more related to disturbance and management activities than to plant associations in this study. McDonald-Dunn Forest has been thinned to capture mortality. Firewood gathering has been another activity affecting snags on the Forest. Natural snag development has not taken place on much of this Forest. Analysis showed that there were no significant differences in the number of snags among the plant associations (Table 9). Snag quality and distribution have been affected by activities in the Forest.

Current snag conditions indicate that at most, 30 percent of the maximum populations for the six woodpecker species analyzed could be supported on this Forest in the stands sampled (Table 10). This appraisal is likely an overestimate. These calculations have not included the size of stands or range necessary for individual species. Species also have requirements for specific decay classes of snags that were not evaluated in this study. These figures also do not take into account the other species that use snags on the Forest that are not included in the SRS model. Most of the woodpeckers studied require snags with diameters of 15 inches or more. The tally of snags available for these species of woodpeckers is from two diameter classes, 12-21 and 21+ inches. If very many snags were in the 12-15" diameter range, the maximum population of woodpeckers the Forest can support would go down even further. These snag numbers are also likely overestimated because they were from the least-disturbed stands and in many cases the furthest away from roads, where wood gathering and thinning were at a minimum as compared to the Forest as a whole.

RECOMMENDATIONS

Six plant associations have been identified on the mature coniferous forests of the McDonald-Dunn Research Forest. Five of these six plant associations had not been previously described elsewhere. These plant associations, identified by their vegetation composition and structure, provide a baseline of information for this point in time to which future vegetation composition and structure of these forests can be compared. The McDonald-Dunn Forest management team can use this information to measure the effects of their management. Maintaining the diversity of the plant associations that now exists in these forests will allow for a healthy and diverse ecosystem of plants and animals.

Emphasis must be placed upon the fact that these mature coniferous forests studied represent only part of the diversity of plant communities that exists in McDonald-Dunn Forest. Riparian areas, meadows, and successional stands of conifers and hardwoods contribute to the overall alpha, beta, and gamma diversity of these lands. These other plant communities are also an essential part of a healthy, diverse, functioning ecosystem. Many species not encountered in this study will be found in riparian, meadow, and hardwood communities. It is recommended that classification work continue on this Forest for riparian areas, meadows, and successional processes. A successional study of the coniferous forests is recommended. A successional study will provide valuable insight into the management implications of harvesting practices. A successional study would be difficult without the baseline information provided by this study.

It is very important that the data from this study be preserved to facilitate future vegetation studies in this area. This study would have been enhanced if the data from Neil West's (1964) vegetation study of this Forest could have been located.

The process of understanding these plant associations has only begun. The plant associations identified here need to be followed through time and studied successionally. The plant associations should be followed in their response to management activities and their development thereafter. The series identified in this study, Tsuga heterophylla, and Abies grandis, represent the potential climax tree species. These potential climax species are hypothesized. Time will be necessary to determine the actual climax species on these forests.

It is also recommended that photographs be taken every ten years on the permanent photo points recorded in this study. This would allow the Forest to pictorially follow the development of these plots through time, whether left undisturbed or if harvested. This photograph record would enhance vegetation studies in the future and help understand successional processes.

The Forest has had the foresight to set aside some old-growth stands (McDonald-Dunn Forest definition of old-growth). It is advised that parcels of mature forests representative of all six plant associations described here be included as reserves. These reserves would have a number of functions. Scientifically and educationally they represent the current diversity of the mature forests in this area, a legacy so to speak. These parcels could be left to reach near climax (late successional) conditions. The Forest management team could learn from these reserves. We could learn the true climax species. We could learn what species are lost in the development towards climax, as well as those species gained. Species richness and structural diversity could be followed. It would be interesting to follow the development of the most seral, productive (Leavell, 1991), and unique plant association in this Forest, TSHE/ACCI-GASH.

The Forest management team is interested in maintaining their old-growth. But merely setting aside these stands will not ensure the maintenance of old-growth forests in McDonald-Dunn. Providing for replacement old-growth stands would be necessary. Having set asides that can be allowed to proceed through natural succession will provide for future old-growth stands. Another way to provide for old for old-growth replacement stands is to first evaluate the composition and structure of their existing old-growth stands in more detail as this study had a limited sample of true old-growth. Then this composition and structure needs to be compared to the structure of the rest of their mature stands (stands sampled in this study). Then they can determine what needs to be done to develop old-growth qualities from these mature, yet younger, stands that now exist. The development through time of the reserves suggested earlier would facilitate the understanding of compositional and structural development towards old-growth forests.

The key for field identification of plant associations on McDonald-Dunn Forest will be tested by field crews in the summer of 1991. Identification of plant associations by the key will be attempted as inventory plots are remeasured (all inventory plots are remeasured every 5 or 10 years). Plot size for occular estimate of percent cover of trees, shrubs, forbs, and grasses will be smaller than the plots used in this study (exact size to be determined by the Forest). All trees, shrubs, forbs, and grasses and cover percent will be recorded. From this information the Forest can construct a plant association map and more accurately know the extent of each plant association. In the case that there are problems with the field key, the vegetation information collected on each inventory plot could be incorporated into new classification analysis. The data collected in this study could be combined with the data collected during plant association identification of the inventory plots to make a revised classification and key.

The Forest has recently been leaving snags and snag replacements in their clearcuts and partial cuts. The Forest may also want to consider some active snag management in their mature forests. This study has shown the current snag levels in these forest to be poor for woodpecker species as a whole on McDonald-Dunn Forest. Most of these woodpeckers require snags of 15 inches in diameter or more. The Forest management team needs to identify the populations of snag-dependent species they want to provide habitat for, and actively work to provide this habitat.

In summary, the plant associations described in this study provide only the first step in understanding vegetation composition, structure, and dynamics on this Forest. Not only does the Forest now have another tool for the purposes described above, but the College of Forestry has a teaching tool for forestry classes. Other disciplines on the University (Botany, Ecology, Soils, etc.) may also use this classification for education and study. Continued effort to study these and other communities on this Forest will be necessary to formulate specific management implications.

BIBLIOGRAPHY

Alekhin, V.V. 1936. Vegetation of the USSR in its main zones (In Russian). In: Fundamentals of Botanical Geography, H. Walter and V. Alekhin, pp. 306-715. Biomedgiz, Moscow and Leningrad.

Anderson, H.G. 1967. The phytosociology of some vine maple communities in the Marys Peak watershed. M.S. Thesis, Oregon State University, Corvallis. 118 pp.

Atzet, T. 1978. Description and classification of the forests of the Upper llinois River drainage of southwestern Oregon. Ph.D Thesis. Oregon State University. 211 pp.

Atzet, T. 1990. USDA For. Serv. Region 6 Area Ecologist. Siskyou National Forest. Personal communication.

Bailey, A.W. 1966. Forest associations and secondary plant succession in the southern Oregon Coast Range. Ph.D. Thesis. Oregon State University. Corvallis. 166 pp.

Braun-Blanquet, J., and H. Jenny. 1926. Vegetations-Entwicklund und Bodenbildung in der alpinaen Stufe der Zentralalpen. Schweiz Naturf. Gesell., Denskschr., 63:181-349.

Braun-Blanquet, J. 1932. Plant sociology: the study of plant communities, trans. and ed. C.D. Fuller and H.S. Conrad. London: Halfner.

Brockmann-Jerosch, H. 1907. Die Planzengesellschaften der Schweizeralpen. I. Die Flora des Puschlav und ihre Pflanzengesellschafen. Engelmann, Leipzig.

Brower, J.E., J.H. Zar, and C.N. von Ende. 1990. Field and laboratory methods for general ecology. Third edition. Wm. C. Brown Publishers.

Buffo, J., L.J. Fritchen, and J. Murphy. 1972. Direct solar radiation in various slopes from 0 to 60 degrees north latitude. USDA For. Serv. Res. Pap. PNW-142.

Cajander, A.K. 1903. Bietrage zur Kenntniss der Vegetation der Alluvionen des nordlichen Eurasiens. Acta. Soc. Sci. Fenn. 37:1-182.

Cajander, A.K. 1909. Ueber Waldtypen. Acta Forest. Fenn. 1.

Clements, F.E. 1902. A system of nomenclature for phytogeography. Englers Jahrbl. 31.

Clements, F.E. 1905. Research methods in ecology. University Publishing Co., Lincoln, NE.

Cowles, H.C. 1899. The ecological relations of the vegetation of sand dunes of Lake Michigan. Bot. Gaz. 27.

Curtis, J.T. 1959. The vegetation of Wisconsin. An ordination of plant communities. Univ. of Wisconsin Press. madison, Wisconsin.

Dansereau, P. 1957. Biogeography, an ecological perspective. Ronald Press, New York.

Daubenmire, R. 1952. Forest vegetation of northern Idaho and adjacent Washington, and its bearing on concepts of vegetation classification. Ecol. Mono. 22:301-330.

Daubenmire, R. 1959. A canopy-coverage method of vegetation analysis. Northw. Sci. 33:43-64.

Daubenmire, R. 1966. Vegetation: identification of typal communities. Science 151:291-298.

Daubenmire, R. 1968. Plant communities: A textbook of synecology. Harper and Row. 300 pp.

dBASE III. 1985. As an unpublished work. Copyright by Ashton-Tate.

DeCalesta, D.S. 1985. Influence of regulation on deer harvest. Pages 131-138. In, S.L. Beasom and S.F. Robinson, eds. Game Harvest Management. Caesar Kleberg Wildlife Res. Inst., Kingsville Texas.

Diaz, N. 1990. USDA For. Serv. Region 6 Area Ecologist. Personal communication.

Drude, O. 1896. Deutschlands Pflanzengeographie. Englehorn, Stuttgart.

Dyrness, C.T., J.F. Franklin, and W.H. Moir. 1974. A preliminary classification of forest communities in the central portion of the western Cascades in Oregon. Bulletin No. 4. Coniferous Forest Biome. Ecosystems Analysis Studies. U.S./International Biological Program. Univ. of Washington, Seattle. 123 pp.

Elliott, C.A. 1990. Diversity indices. In M.L. Hunter Jr. Wildlife, forests, and forestry. pp. 68-69. Prentice Hall. Englewood Cliffs, N.J.

Flahault, C. 1893. Les sones botaniques dans le Bas-Languedoc et les pays voisins. Bull. Soc. Bot. France 40:36-62.

Franklin, J.F., and C.T. Dyrness. 1984. Natural vegetation of Oregon and Washington. OSU Press. Corvallis, OR. 452 pp.

Garrison, G.A., J.M. Skovlin, E.C. Poulton, and A.H. Winward. 1976. Northwest plant names and symbols for ecosystem inventory and analysis. Fourth edition. USDA For. Serv. Gen, Tech. Rep. PNW - 46, Pac. Northw. For. and Range Exp. Sta., Portland, Oregon. 263 pp.

Gauch, H.G. 1981. Catalog of the Cornell ecology program series. Ecology and Systematics, Cornell University, Ithaca. N.Y.

Gauch, H.G. 1982. Multivariate analysis in community ecology. Cambridge University Press, New York. 298 pp.

Gauch, H.G., and R.H. Whittaker. 1981. Hierarchial classification of community data. J. of Ecology 69:537-557.

Gilkey, M.M., and L.J. Dennis. 1980. Handbook of Northwestern plants. Oregon State University Bookstores, Inc. Corvallis, Oregon. 507 pp.

Gleason, H.A. 1926. The individualistic concept of the plant association. Bull. Torrey Bot. Club 53:7-26.

Hall, F.C. 1973. Plant communities of the Blue Mountains in eastern Oregon and southwestern Washington. R-6 Area Guide 3-1. Portland, Oregon. USDA For. Serv., Pac. Northwest Region. 62 pp.

Hall, F.C. 1989. Plant association and management guide for the Ochoco and southern Blue Mountain areas (Draft). USDA For. Serv. Pac. Northwest Region. R6 ECOL TP-00-90. 195 pp.

Hall, J.K. and P.B. Alaback. 1982. Preliminary checklist of the vascular flora of McDonald and Paul Dunn state forests. Special publication 3. Forest Research Laboratory, Oregon State University. 42 pp.

Halpern, C. 1990. USDA For. Serv. Ecologist. Pacific Northwest Research Station. Corvallis, OR. Personal communication.

Halverson, N.M., C. Topic, and R. Van Vickle. 1986. Plant association and management guide for the Western Hemlock Zone, Mt. Hood N.F. U.S.D.A. Forest Service. PNW Region, R6-ECOL-232A-1986. 111 pp.

Hemstrom, M.A., and S. Logan. 1986. Plant association and management guide, Siuslaw National Forest. USDA Forest Service, PNW Region. R6-ECOL 200-1986a. Portland. 121 pp.

Hemstrom, M.A., S. Logan, and W. Pavlat. 1987. Plant association and management guide, Willamette National Forest. USDA Forest Service, PNW Region. R6-ECOL 257-B-86. Portland. 312 pp.

Hemstrom, M.A. 1990. USDA For. Serv. Region 6 Area Ecologist. Willamette National Forest. Eugene, Or. Personal communication.

Hanson, H.C. 1962. Dictionary of ecology. Philos. Libr., New York, 382 pp.

Hill, M.O. 1973. Reciprocal averaging: an eigenvector method of ordination. J. Ecol. 61: 237-249.

Hill, M.O. 1979a. DECORANA - A FORTRAN program for detrended correspondence analysis and reciprocal averaging. Section of Ecology and Systematics (unpub.). Cornell University, Ithaca, NY. 30 pp.

Hill, M.O. 1979b. TWINSPAN - A FORTRAN program for arranging multivariate data in an ordered two-way table by classification of the individuals and attributes. Section of Ecology and Systematics (unpub.). Cornell University, Ithaca, NY. 48 pp.

Hill, M.O., R.G.H. Bunce, and M.W. Shaw. 1975. Indicator species analysis, a divisive polythetic method of classification, and it's application to a survey of native pinewoods in Scotland. J. of Ecology 63:579-613.

Hitchcock, A.S., and A. Cronquist. 1973. Flora of the Pacific Northwest. University of Washington Press, Seattle and London. 730 pp.

Humboldt, A. von. 1805. Essai sur la Geographie des Plantes: accompagne d'un tableau physique des regions equinoxiales. Levrault, Paris.

Hubbard, C.E. 1954. Grasses. Penguin Books.

Ilveslao, Y. 1920. Untersuchungen uber taxatorische Bedeutung der Waldtypen. Acta Forest. Fenn. 15.

Jackson, R.G. 1981. McDonald-Dunn Forests: Human use and occupation. Corvallis, Oregon. 404 pp.

Juday, G.P. 1976. The location, composition, and structure of old-growth forests of the Oregon Coast Range. Ph.D. Thesis. Oregon State University. Corvallis. 206 pp.

Knezevich, C.A. 1975. Soil survey of Benton Co., Oregon. USDA, Soil Conservation Service, in cooperation with Oregon Agricultural Experiment Station. Oregon State University, Corvallis. 119 pp.

Krajina, V.J. 1959. Can we find a common platform for the different schools of forest type classification. Pages 50-55. In: Silva Fennica No. 105 (1960) Symposium on forest types and forest ecosystems during the IX International Botanical Congress, Montreal, August 24, 1959.

Lakari, O.J. 1920. (Referat). Untersuchungen uber die Walktypen in Nordfinnland. Acta Forest. Fenn. 14.

Lambert, J.M., S.E. Meacock, J. Barrs, and P.F. Smartt. 1973. Axor and monit: Two new polythetic-divisive strategies for hierarchial classification. Taxon 22(2/3):173-176.

Leavell, D.M. 1991. Relationships between plant associations and environment within McDonald-Dunn Forest. Unpubl. Master's Thesis. College of Forestry, Oregon State University, Corvallis, Oregon. 176 pp.

Leavell, D.M., and C.J. Hubbard. 1989. The presence of Brachypodium sylvaticum in McDonald-Dunn Forest. Unpub. 14 pp.

MacIntosh, P.P. 1967. The continuum concept of vegetation. Bot. Rev. 33:131-187.

Madgwick, H.A., and P.A. Desrochers. 1971. Association-Analysis and the classification of forest vegetation of the Jefferson National Forest. J. of Ecology 59:285-292

Marcot, B. 1989. Documentation: Snag recruitment simulator (SRS). USDA Forest Service, Mt Hood National Forest.

McComb, W., and C. Chambers. 1989. Comparisons of terrestrial vertebrate communities and tree regeneration among 3 silvicultural systems in the east-central Coast Range, Oregon. Unpub. Oregon State University. 9 pp.

McCune, B. 1987. Multivariate analysis on the PC-ORD system. A software documentation report. Holcomb Research Institute Report # 75. Buttler University. Indianapolis, Indiana.

Means, J.E., 1980. Dry coniferous forests in the western Oregon Cascades. Ph.D Thesis. Oregon State University, Corvallis. 268 pp.

Merkle, J. 1948. An analysis of the plant communities of Marys Peak, western Oregon. Ph.D Thesis. Oregon State College, Corvallis. 95 pp.

Mielke Jr., P.W., J. Berry, G.W. Brier. 1981. Application of multi-response permutation procedures for examining seasonal change in monthly mean sea-level pressure patterns. Monthly Weather Review: 109:120- 126.

Moral, P.D., and R.S. Flemming. 1979. Structure of coniferous forest communities in western Washington: diversity and ecotope properties. Vetetatio 41(3):143-154.

Neitro, W.A., V.W. Binkley, S.P. Cline, R.W. Mannan, B.G. Marcot, and F.F. Wagner. 1985. Snags (Wildlife Trees). pp. 129-169. In: Brown, R.E. ed. Management of Wildlife and Fish Habitats in Forests of Western Oregon and Washington (Part 1 and 2). U.S.D.A. PNW Region, Portland, OR. 322 pp.

Norrlin, J.P. 1870. Bidrag till sydostra Tavastlands flora. Sallsk Fauna och Flora Fennica Not. 11:73-196.

Noss, R.F. 1983. A regional landscape approach to maintain diversity. BioScience 33(11):700-706.

Odum, E.P. 1953. Fundamentals of ecology. Saunders, Philadelphia-London.

Oosting, H.I. 1956. The study of plant communities. Freeman, San Francisco. 2nd edition.

Orloci, L. 1966. An agglomerative method for classification of plant communities. J. of Ecology 55:193-206.

Overton, W.S., B.G. Smith, and C.D. McIntire. 1987. Aid programs (analysis of information and diversity. Unpublished. Oregon State Univ., Corvallis, OR.

Pfister, R.D., B.L. Kovalchik, S.F. Arno, and R.C. Presly. 1977. Forest habitat types of Montana. USDA For. Serv. Gen. Tech. Rep. INT-34, Intermt. For. and Range Exp. Stn., Ogden, Utah. 174 pp.

Pound, R., and F.E. Clements. 1898. The vegetation regions of the prairie province. Bot. Gaz. 25:381-94.

Quatro Pro Manual. 1987. Borland International. Scotts Valley Drive, Scotts Valley, CA.

Raisz, E. 1941. Landforms of the northwestern states (map). Inst. of Geographical Exploration, Harvard Univ.

Rowley, M., and S. Jorgensen. 1983. Oregon State University College of Forestry research forest properties soil survey. Unpub. School of Forestry, Oregon State University. 101 pp.

Rowley, M. 1989. Stand histories for McDonald-Dunn Forest (untitled, listed by stand no.). Unpub. Oregon State University, College of Forestry Research Forest, Corvallis.

Sabhasri, S., and W.K. Ferrell. 1960. Invasion of brush species into small stand openings in the Douglas-fir forests of the Willamette foothills. Northwest Science 34(3):77-88.

SAS Institute Inc. 1985. SAS Procedures Guide for Personal Computers. SAS Institute Inc., Carey, NC.

Schroeder, R.L. 1987. Community models for wildlife impact assessment: A review of concepts and approaches. National Ecology Center. Division of Wildlife and Contaminant Research, Fish and Wildlife Service, U.S. Dept. of the Interior, Washington, DC.

Shimwell, D.W. 1971. The description and classification of vegetation. Univ. of Washington Press, Seattle. 332 pp.

Singer, S.B., and H.G. Gauch. 1979. CONDENSE--convert data matrices from any ORDIFLEX format into a condensed format by samples. Ecology and Systematics, Cornell University, Ithaca, New York. 7 pp.

Smith, B. 1990. USDA For. Serv. Region 6 Assistant Area Ecologist. Personal communication.

Smith, R.L. 1980. Ecology and field biology. Third edition. Harper and Row, New York.

Sprague, F.L., and H.P. Hansen. 1946. Forest succession in the McDonald Forest, Willamette Valley, Oregon. Northwest Science 20:89-98.

Stafford, S.G., P.B. Alaback, G.J. Koerper, M.W. Klopsch. 1984. Creation of a Forest Science data bank. J. of Forestry Vol. 82(7):432-433.

Sukacev, V.N. 1928. Plant communities (Introduction to phytosociology) (In Russian). 4th edition. Kniga, Leningrad and Moscow.

Sukacev, V.N. 1945. Biogeocoenology and phytocoenology. Dokl. Akad. Nauk SSSR 47(6):447-449.

Svoboda. P. 1949. Prinos sovetske vedy k lesni typologii. Lesnicka Prace 28.

Tansley, A.G. 1920. The classification of vegetation and the concept of development. J. of Ecol. 8.

Thilenius, J.F. 1968. The Quercus garryana forests of the Willamette Valley, Oregon. Ecology 49(6):1124-1133.

Thomas, J.W. 1979. Wildlife habitats in managed forests: the Blue Mountains of Oregon and Washington. USDA Forest Service Agriculture Handbook No. 553. 512 pp.

Topik, C., N.M. Halverson, and T. High. 1988. Plant association and management guide for the ponderosa pine, Douglas-fir, and grand fir zones. Mt. Hood National Forest. USDA Forest Service, PNW Region, R6-ECOL-TP-004-88. 136 pp.

USDA Forest Service. 1962. Instructions for type mapping forest types in the Pacific Northwest Region, Division of Timber Management, Pacific Northwest Region. Portland.

Waring, R.H., and J.F. Franklin. 1979. Evergreen coniferous forests of the Pacific Northwest. Science 204:1380-1386.

West, N.E. 1964. Vegetation mapping project on the McDonald and Paul Dunn Forests of the School of Forestry, Oregon State University. Unpub. (located only portions of project).

Westhoff, V., and E. Maarel. 1973. The Braun-Blanquet approach. Pages 617-707. In: R.H. Whittaker, ed. Ordination and classification of communities. The Hague: Junk.

Westman, W.E. 1990. Managing for biodiversity: unresolved science and policy questions. BioScience 40(1):26-33.

Whittaker, R.H. 1962. Classification of natural communities. Bot. Rev. 28:1-239.

Whittaker, R.H. 1967. Gradient analyses of vegetation. Biol. Rev. London 42:207-264.

Whittaker, R.H. 1972. Evolution and measurement of species diversity. Taxon 21 (2/3):213-251.

Whittaker, R.H. 1973. Handbook of vegetation science. Part V. Ordination and classification of communities. The Hague: W. Junk. 737 pp.

Whittaker, R.H. 1975. Communities and ecosystems. 2nd ed. Macmillan. New York. 385 pp.

Witmer, G.W., M. Wisdom, E.P. Harshman, R.J. Anderson, C. Carey, M.P. Kurlel, I.D. Luman, J.A. Rochelle, R.W. Scharof, and D. Smithey. 1985. Deer and Elk. Pages 231-258. In: Management of wildlife and fish habitats in forests of western Oregon and Washington. Part 1 - Chapter narratives. USDA Forest Service Pac. Northw. Region, 1985: 231-258.

Woodbury, A.M. 1954. Principles of general ecology. Blakiston, New York-Toronto.

Zimmerman, G.M., H. Goetz, and P.W. Mielke, Jr. 1985. Use of an improved statistical method for group comparisons to study effects of prairie fire. Ecology 66(2):606-611.

APPENDICES

Appendix 1. Ecology plot location descriptions.

Ecology plot #	Forest Inventory plot #	Tract	Compartment	Stand	Township, Section, Range
1	1015	7	9	7	T.11S.R.5W.SW1/4SEC.18
2	1008	7	9	7	T.11S.R.5W.SE1/4SEC.18
3	1502	7	10	4	T.11S.R.5W.SE1/4SEC.18
4	306	7	4	3	T.11S.R.5W.SW1/2SEC.8
5	303	7	9	9	T.11S.R.5W.NE1/4SEC.19
6	307	7	9	9	T.11S.R.5W.NE1/4SEC.19
7	502	7	11	11	T.11S.R.5W.NW1/4SEC.20
8	806	7	7	3	T.11S.R.5W.NW1/4SEC.17
9	610	7	7	3	T.11S.R.5W.NE1/4SEC.18
10	301	4	19	1	T.10S.R.5W.NE1/4SEC.36
11	1101	4	17	5	T.10S.R.5W.SE1/4SEC.36
12	801	4	17	5	T.10S.R.5W. W1/2SEC.36
13	501	4	23	1	T.10S.R.5W.SE1/4SEC.36
14	303	4	22	1	T.10S.R.5W.SW1/4SEC.36
15	400	4	21	7	T.10S.R.5W.SE1/4SEC.35
16	700	4	6	5	T.10S.R.5W.SW1/4SEC.25
17	201	4	10	6	T.10S.R.5W.NE1/4SEC.36
18	700	4	7	3	T.10S.R.5W.SE1/4SEC.25
19	1301	4	6	5	T.10S.R.5W.SW1/4SEC.25
20	607	4	17	1	T.10S.R.5W.NW1/4SEC.36
21	407	7	6	5	T.11S.R.5W.NW1/4SEC.18
22	411	7	6	3	T.11S.R.5W.NW1/4SEC.18
23	405	7	6	5	T.11S.R.5W.NW1/4SEC.18
24	300	7	6	6	T.11S.R.5W.NE1/4SEC.18
25	1403	7	11	1	T.11S.R.5W.SW1/4SEC.17
26	500	7	5	1	T.11S.R.5W.SE1/4SEC.8
27	403	6	5	3	T.11S.R.5W.SE1/4SEC.8
28	406	6	5	1	T.11S.R.5W.SE1/4SEC.8
29	504	6	5	3	T.11S.R.5W.SE1/4SEC.8
30	302	7	6	5	T.11S.R.5W.SW1/4SEC.9
31	902	6	8	10	T.11S.R.5W.NW1/4SEC.16
32	402	6	8	5	T.11S.R.5W.NW1/4SEC.16
33	802	6	8	9	T.11S.R.5W.NW1/4SEC.16
34	601	6	3	8	T.11S.R.5W.NE1/4SEC.9
35	201	6	2	1	T.11S.R.5W.NE1/4SEC.9
36	501	6	2	4	T.11S.R.5W.NE1/4SEC.9
37	602	6	2	3	T.11S.R.5W.NW1/4SEC.9
38	605	1	7	3	T.10S.R.5W.SW1/4SEC.9
39	600	1	7	1	T.10S.R.5W.SE1/4SEC.8
40	600	1	5	11	T.10S.R.5W.SW1/4SEC.9
41	607	1	1	7	T.10S.R.5W.SW1/4SEC.5
42	104	7	4	6	T.11S.R.5W.SW1/4SEC.8
43	212	7	7	3	T.11S.R.5W.NW1/4SEC.19
44	303	1	9	3	T.10S.R.5W.NE1/4SEC.9
45	502	1	9	3	T.10S.R.5W.NW1/4SEC.9
46	704	1	9	5	T.10S.R.5W.NW1/4SEC.16
47	901	2	2	8	T.10S.R.5W.NW1/4SEC.16
48	1007	2	2	5	T.10S.R.5W.NE1/4SEC.16
49	808	2	2	5	T.10S.R.5W.NE1/4SEC.16
50	302	2	4	1	T.10S.R.5W.NE1/4SEC.21
51	1105	2	3	2	T.10S.R.5W.NW1/4SEC.15
52	805	3	8	12	T.10S.R.5W.NW1/4SEC.15
53	1104	3	7	1	T.10S.R.5W.SE1/4SEC.22
54	705	1	5	1	T.10S.R.5W.NE1/4SEC.8
55	1401	1	4	1	T.10S.R.5W.NW1/4SEC.8
56	900	1	6	1	T.10S.R.5W.NW1/4SEC.8
57	1101	1	3	3	T.10S.R.5W.NW1/4SEC.8
58	307	1	2	5	T.10S.R.5W.NW1/4SEC.15

Appendix 1. (Continued)

Ecology plot #	Forest Inventory plot #	Tract	Compartment	Stand	Township, Section, Range
59	506	1	2	1	T.10S.R.5W.NE1/4SEC.7
60	404	1	3	4	T.10S.R.5W.SW1/4SEC.8
61	302	6	2	1	T.11S.R.5W.SE1/4SEC.4
62	403	6	2	1	T.11S.R.5W.SE1/4SEC.4
63	405	6	2	1	T.11S.R.5W.SE1/4SEC.4
64	409	6	2	1	T.11S.R.5W.SW1/4SEC.4
65	602	5	11	1	T.11S.R.5W.SW1/4SEC.3
66	209	5	11	1	T.11S.R.5W.NW1/4SEC.10
67	201	5	10	1	T.11S.R.5W.SW1/4SEC.3
68	601	5	10	1	T.11S.R.5W.SW1/4SEC.3
69	302	5	7	6	T.11S.R.5W.NW1/4SEC.3
70	600	5	1	6	T.10S.R.5W.SW1/4SEC.35
71	105	5	5	9	T.11S.R.5W.NE1/4SEC.3
72	1100	5	3	6	T.10S.R.5W.SE1/4SEC.35
73	301	8	6	3	T.11S.R.5W.SE1/4SEC.5
74	502	8	5	2	T.11S.R.5W.SW1/4SEC.5
75	1011	3	3	5	T.10S.R.5W.SE1/4SEC.14
76	1102	3	3	4	T.10S.R.5W.SW1/4SEC.14
77	1403	3	1	3	T.10S.R.5W.SW1/4SEC.14
78	405	3	2	6	T.10S.R.5W.NE1/4SEC.22
79	1001	3	5	4	T.10S.R.5W.SE1/4SEC.22
80	1200	1	1	2	T.10S.R.5W.SW1/4SEC.5
81	1402	2	6	4	T.10S.R.5W.SE1/4SEC.21
82	205	2	5	10	T.10S.R.5W.NW1/4SEC.22
83	803	3	7	4	T.10S.R.5W.SW1/4SEC.22
84	503	3	6	6	T.10S.R.5W.SE1/4SEC.22
85	1602	3	7	2	T.10S.R.5W.SE1/4SEC.22
86	1206	3	6	6	T.10S.R.5W.SW1/4SEC.23
87	601	3	8	10	T.10S.R.5W.NW1/4SEC.27
88	106	6	9	1	T.11S.R.5W.NE1/4SEC.16
89	408	6	9	1	T.11S.R.5W.NE1/4SEC.16
90	403	6	10	3	T.11S.R.5W.SE1/4SEC.16
91	810	7	11	1	T.11S.R.5W.SW1/4SEC.17
92	1008	7	11	1	T.11S.R.5W.SW1/4SEC.17
93	202	7	7	2	T.11S.R.5W.NW1/4SEC.17
94	1302	7	9	5	T.11S.R.5W.SE1/4SEC.18
95	203	7	6	6	T.11S.R.5W.NE1/4SEC.18
96	1406	7	10	3	T.11S.R.5W.SE1/4SEC.18
97	604	6	4	4	T.11S.R.5W.NW1/4SEC.10
98	104	6	4	1	T.11S.R.5W.NW1/4SEC.10
99	602	6	8	7	T.11S.R.5W.NW1/4SEC.16
100	406	6	3	6	T.11S.R.5W.NE1/4SEC.9
101	604	6	3	14	T.11S.R.5W.NE1/4SEC.9
102	204	6	6	5	T.11S.R.5W.NE1/4SEC.9
103	101	6	1	1	T.11S.R.5W.SW1/4SEC.4
104	1002	6	8	11	T.11S.R.5W.NE1/4SEC.17
105	1009	6	8	9	T.11S.R.5W.NW1/4SEC.16
106	800	6	10	6	T.11S.R.5W.SW1/4SEC.16
107	805	8	1	6	T.11S.R.5W.SW1/4SEC.6
108	507	8	1	7	T.11S.R.5W.SW1/4SEC.6
109	706	8	1	7	T.11S.R.5W.SW1/4SEC.6
110	803	8	1	6	T.11S.R.5W.SW1/4SEC.6
111	1006	8	1	4	T.11S.R.5W.NW1/4SEC.6
112	1105	8	1	2	T.11S.R.5W.NW1/4SEC.6
113	901	8	2	10	T.11S.R.5W.NE1/4SEC.6
114	101	8	4	11	T.11S.R.5W.NE1/4SEC.6
115	406	8	4	17	T.11S.R.5W.SE1/4SEC.6

Appendix 2. Plot sheets used for the survey.

ECOLOGY PLOT CARD 1

PLOT#________ INV.PLOT#__________ DATE:______________
TRACT______COMPARTMENT_______STAND_______
COMMUNITY____
PHOTOS 1______________ 2____________ B&W ROLL #__________ COLOR ROLL#__________
LOCATION T__________R__________SECTION____________
LOCATION DESCRIPTION____

PLOT	1	____	PLOT NUMBER
ELEV	2	____	NEAREST 100' (4 DIGITS)
*ASPECT	3	____	ASPECT, COMPASS AZIMUTH
*SLOPE	4	____	SLOPE PERCENT
*MICPOS	5	____	MICROPOSITION: 1=TOP; 2=TOP OF SLOPE; 3=MID-SLOPE; 4=BOTTOM OF SLOPE; 5=BENCH; 6=TOE; 7=BOTTOM; 8=BASIN; 9=DRAW
*MICROV	6	____	MICRORELIEF VERTICAL 1=CONV; 2=FLAT;
*MICROH	7	____	MICRORELIEF HORIZONTAL 3=CONC; 4=UND
*TREEM	8	____	% THERMAL TREE COVER (50+) HW_____ CON_____
*THERM	9	____	% HIDING TREE COVER (12-50') HW_____ CON_____
*TREER	10	____	% REGENERATING TREE COVER (<12' TALL)
*SHRUB	11	____	% SHRUB COVER
*FORB	12	____	% FORB COVER
*GRASS	13	____	% GRASS COVER
*MOSS	14	____	% MOSS COVER
*BRGRD	15	____	% BARE GROUND; SURFACE COARSE FRAG. <1/16" DIA.
*GRAVEL	16	____	% GRAVEL: SURFACE COARSE FRAG. BETW. 1/16"&3" DIA.
*ROCK	17	____	% SURFACE COARSE FRAGS. GREATER THAN 3" DIA.
*BDROCK	18	____	% SURFACE BEDROCK EXPOSED
*BROCK	19	____	% SURFACE BEDROCK WITH MOSS OR LITTER COVER
TLBA	20	____	LIVING BASAL AREA (SQ.FT.)
AGE	21	____	STAND AGE
HEIGHT	22	____	AVERAGE STAND HEIGHT
DBH	23	____	QUADRATIC MEAN DIAMETER
SI	24	____	SITE INDEX (KING'S)
SDI	25	____	STAND DENSITY INDEX
*SNAGS	26	____	# OF SNAGS (50 M RADIUS)
*SOIL SER	27	____	VERIFIED SOIL SERIES
*SOIL DEP	28	____	SOIL DEPTH TO BEDROCK
*SOIL ROCK	29	____	% ROCK CONTENT IN TOP 18" OF SOIL

4-12		12-21		21+	
HW	CON	HW	CON	HW	CON
____	____	____	____	____	____

QUADRANTS: CAVITY ESTIMATE OF CLOSEST SNAG IN EACH QUADRANT

	# OF CAVITIES	DISTANCE	SPECIES	
SNG1	____	____	____	QUAD 1 (0-90 AZ)
SNG2	____	____	____	QUAD 2 (91-180 AZ)
SNG3	____	____	____	QUAD 3 (181-270 AZ)
SNG4	____	____	____	QUAD 4 (271-360 AZ)

2 CLOSEST SNAGS 1______FT_____QUAD 2________FT________QUAD

*VERTICAL COMPLEXITY INDEX:

	COVER %	SCATTERED	PATCHY	GROUPED	
LOW SHRUB	____	____	____	____	(<2 FEET)
MED SHRUB	____	____	____	____	(2-6 FEET)
TALL SHRUB	____	____	____	____	(6+ FEET)

COMMENTS:____

* Indicates field observations

Appendix 2. (cont.)

ECOLOGY PLOT CARD - 2

PLOT#__________ DATE:______________

TREES

<12' CC/%	12-50 CC/%	50+ CC/%	Name Code	Scientific Name	Comments
			PSME		
			ABGR		
			ACMA		

SHRUBS

CC	Height	Code	Scientific name	Comments
		COCO		HAZEL
		RHDI		POISON OAK
		HODI		OCEAN SPRAY
		SYAL		SNOWBERRY
		RUUR		TRAILING BB
		RULA		EVERGREEN BB
		RUDI		HIMALAYAN BB
		ROSE		ROSE SPP
		RUPA		THIMBLEBERRY

FERNS

		PTAQ		BRACKEN
		POMU		SWORD

FORBS

		OSCH		SW CICELY
		GATR		BEDSTRAW
		SADO		YERBA BUENA
		ADBI		PATHFINDER
		MOSI		MINERS LETTUCE
		ACTR		VANILLA LEAF
		TRLA		STAR FLOWER
		GOOB		RATTLESNAKE PLANTAIN

GRASSES

COMMENTS:____________________

Appendix 2. (cont.)

SOILS DESCRIPTION

PLOT#________ INV.PLOT#____________ DATE____________

DEPTH	COLOR	TEXTURE	% COARSE FRAGMENTS (&SIZE)	COMMENTS

____________ SOIL SERIES
____________ SOIL DEPTH REACHED
____________ % COARSE FRAGMENTS IN TOP 18" OF SOIL
____________ COLOR IN TOP 18"
____________ TEXTURE OF TOP 18"

ADDITIONAL COMMENTS ON SOILS:____________

Appendix 2. (cont.)

HISTORICAL COMMENTARY

PLOT# _______ INV PLOT #_________ DATE:___________

LOGGING DISTURBANCE_______________________________________

OTHER DISTURBANCE_______________________________________

TIME SINCE DISTURBANCE_______________________________________

DEGREE OF RECOVERY_______________________________________

SILVICULTURAL HISTORY_______________________________________

NATURAL HISTORY_______________________________________

STAND SUCCESSION_______________________________________

STAND STRUCTURE_______________________________________

OTHER COMMENTS:

Appendix 3. Description of ecology plot data.

**** IMPORTANT NOTE: Field numbers on plot sheets will not correspond to the field numbers listed below, but these numbers will correspond to the field numbers in dBASE III.

Field Name	Description and Ranges
1.ECOPLOT	Ecology Plot number (1-115) Limited to 3 numbers.
2.INVPLOT	Forest Inventory Plot number (ex. 0701) Limited to 4 numbers, the first two numbers indicate transect #, the 2nd two numbers indicate plot # within transect.
3.TT	Timber Type. (ex. D4=/gf-) Standard type codes used for Forest timber typing.
4.DATE	Date plot data recorded. (ex. 09/26/89)
5.TRACT	Tract in which plot is located. (ex. 07)
6.COMPARTM	Compartment within tract where plot is located. (ex.05)
7.STAND	Stand # within tract and compartment. (ex. 11)
8.PLANTCOM	Plant Community as defined by dominant tree species, dominant shrub species, dominant herb species, and dominant grass species. (ex. PSME-ACMA/COCO/POMU)
9.TRSEC	Township, Section, and Range; legal description of plot location. Correct way to document: (ex. T.11S.R.5W.SW1/4Sec.18)
10.ELEV	Elevation. Limited to 4 numbers. (ex. 0925)
11.ASPECT	Azimuth. 1-360 degrees. (ex. 285)
12.SLOPE	Slope percent. (ex. 36)
13.MICPOS	Microposition: Where on slope plot is located. 1=Top 2=Top of slope 3=Mid-slope 4=Bottom of slope 5=Bench 6=Toe of slope 7=Bottom of slope 8=Basin 9=Draw
14.MICROV	Vertical Microrelief: Relief on vertical axis, up and down the slope. 1=Convex 2=Flat 3=Concave 4=Undulating

Appendix 3. (cont.)

15.MICROH	Horizontal Microrelief: Relief on horizontal axis, across the slope. Same 4 descriptions as in MICROV (#14).
16.TREEM	Percent Thermal Tree Cover: percent of tree crown cover from trees 50' tall or taller.
17.THERM	Percent Hiding Tree Cover: percent of tree crown cover from trees between 12 and 50 feet tall.
18.TREER	Percent Regenerating Tree Cover: percent of tree crown cover from trees less than 12 feet tall.
19.SHRUB	Percent Shrub Cover.
20.FORB	Percent Herb Cover.
21.GRASS	Percent Grass Cover.
22.MOSS	Percent Moss cover.
23.BRGRND	Percent Bare Ground &/or ground covered by surface coarse fragments that are less than 1/16 inch in diameter.
24.GRAVEL	Percent Gravel. Percent of ground covered by surface coarse fragments that are between 1/16 inch and 3 inches in diameter.
25.ROCK	Percent Rock. Percent of ground covered by coarse fragments that are greater than 3 inches in diameter.
26.BDROCK	Percent Bedrock. Percent of ground covered by exposed bedrock.
27.BROCK	Percent surface bedrock that is covered with moss or litter.
28.TLBA	Total Live Basal Area, expressed in board feet, for conifers only.
29.AGE	Age of stand.
30.HEIGHT	Average height of trees in variable plot.
31.DBH	Average Diameter, in inches, at Breast Height (4.5') of trees in variable plot.
32.SI	Site Index.
33.SDI	Stand Density Index.
34.SNAGS	Number of snags within a 150 foot radius from plot center.

Appendix 3. (cont.)

35.MAPSSER Mapped Soil Series. From the Forest's soils inventory. Names are as follows:

Price
Ritner
Jory
Witzel
Dixonville
Philomath
Hazelair
Steiwer
Abiqua

36.MAPSSERN Mapped Soil Series Number. This is the number that we are using to correspond to the soil series for statistical purposes.

1=Price
2=Ritner
3=Jory
4=Witzel
5=Dixonville
6=Philomath
7=Hazelair
8=Steiwer
9=Abiqua

37.ACTSSER Actual Soil Series name. This is the soil series that we found to actually exist, which didn't always correspond to the mapped soil series. Names are as listed in field #35.

38.ACTSSERN Actual Soil Series Number. This is the number corresponding to the actual soil series found to exist on the plot. Use the same number codes as listed in Field #34.

39.DEPTH Depth of soil in inches. Depths were taken to 60 inches since that is the limitation of the soil auger used. in some cases 60+ was recorded on data sheet, but not in dBASE.

40.PRCROCK Percent Rock in the top 18 inches of soil.

41.COLOR Dominant color of the top 18 inches of soil. Field possibilities are:

BRN
DK RED BRN
RED BRN
BLK
DK BRN
VERY DK GRY BRN
DK YELLOW BRN
YELLOW RED

Appendix 3. (cont.)

42.COLORN — Soil color corresponding numeric field.
1=BRN
2=DK RED BRN
3=RED BRN
4=BLK
5=DK BRN
6=VERY DK GRY BRN
7=DK YELLOW BRN
8=YELLOW RED

43.TEXTURE — Dominant texture of the top 18 inches of soil. Field possibilities are:
Loamy sand
Sandy loam
Sandy clay loam
Sandy clay
Loam
Clay loam
Clay
Silt loam
Gravelly silt loam
Light silty clay loam
Silty clay loam
Gravely silty clay loam
Extremely gravely silty clay loam
Heavy silty clay loam
Silty clay
Silt

44.TEXTUREN — Numeric field corresponding to the texture of the top 18 inches of soil:
1=Loamy sand
2=Sandy loam
3=Sandy clay loam
4=Sandy clay
5=Loam
6=Clay loam
7=Clay
8=Silty loam
9=Gravelly silt loam
10=Light silty clay loam
11=Silty clay loam
12=Gravelly silty clay loam
13=Extremely gravelly silty clay loam
14=Heavy silty clay loam
15=Silty clay
16=Silt

Appendix 4. Complete species list.

Species used in the analysis are marked with an (*).

List includes all weeds and species that only occurred once or twice in plots.

TREES

SPP #	SPP. CODE	SCIENTIFIC NAME	COMMON NAME
1,2,3	ABGR	Abies grandis	grand fir
4,5,6	ACMA	Acer macrophyllum	bigleaf maple
7,8,	ALRU	Alnus rubra	red alder
13,14,	ARME	Arbutus menziesii	Pacific madrone
16,17,	CONU	Cornus nuttallii	Pacific dogwood
19,20,21	FRLA	Fraxinus latifolia	Oregon ash
24	PIPO	Pinus ponderosa	ponderosa pine
31,32,33	PRUNU	Prunus spp.	cherry
34,35,36	PREM	Prunus emarginata	bitter cherry
40,41,42	PSME	Pseudotsuga menziesii	Douglas-fir
46,47,48	QUGA	Quercus garryana	Oregon white oak
49,50,51	TABR	Taxus brevifolia	Pacific yew
52,53,54	THPL	Thuja plicata	western redcedar
176,177,178	TSHE	Tsuga heterophylla	western hemlock

SHRUBS

55	ACCI	*	Acer circinatum	vine maple
56	AMAL	*	Amelanchier alnifolia	western serviceberry
57	BEAQ	*	Berberis aquifolium	Oregon hollygrape
58	BENE	*	Berberis nervosa	Cascade hollygrape
61	COCO	*	Corylus cornuta	hazel
62	COST		Cornus stolonifera	red-osier dogwood
63	CRATA		Crataegus spp.	hawthorn
64	CRMO		Crataegus monogyna	one-seed hawthorn
65	GASH	*	Gaultheria shallon	salal
66	HODI	*	Holodiscus discolor	ocean-spray
174	HOLLY		Holly spp.	holly
68	LOCI	*	Lonicera ciliosa	western trumpet honeysuckle
69	LOHI	*	Lonicera hispidula	hairy honeysuckle
70	OECE		Oemleria cerastiformis	indian plum
71	RHPU	*	Rhamnus purshiana	cascara buckthorn
72	RHDI	*	Rhus diversiloba	poison oak
73	RIDI	*	Ribes divaricatum	straggly gooseberry
74	ROSA	*	Rosa spp.	rose
76	RULA	*	Rubus laciniatus	cutleaf blackberry
77	RULE	*	Rubus leucodermis	black cap raspberry
78	RUPA	*	Rubus parviflorus	western thimbleberry
79	RUDI	*	Rubus discolor	Himalayan blackberry
81	RUUR	*	Rubus ursinus	trailing blackberry
82	SAGL	*	Sambucus glauca	blue elderberry
83	SALI		Salix spp.	willow
84	SAMBU		Sambucus spp.	elderberry spp
86	SYAL	*	Symphoricarpos albus	common snowberry
87	SYMO	*	Symphoricarpos mollis	
88	VAPA	*	Vaccinium parviflorum	red whortleberry

Appendix 4. (Cont.)

FORBS (ferns)

91	BLSP		Blechnum spicant	deer fern
92	POGL		Polypodium glycyrrhiza	licoricefern
93	POMU	*	Polystichum munitum	western swordfern
94	PTAQ	*	Pteridium aquilinum	bracken fern

FORBS

96	ACTR	*	Achlys triphylla	deerfoot vanillaleaf
97	ACRU	*	Actaea rubra	baneberry
98	ADBI	*	Adenocaulon bicolor	pathfinder
99	ANDE	*	Anemone deltoidea	
100	ANMA		Anaphalis margaritaceae	pearly everlasting
101	AQFO		Aquilegia formosa	sitka columbine
102	ARMI		Arctimum minus	common burdock
103	ARMA	*	Arenaria macrophyllum	bigleaf sandwort
104	ASCA	*	Asarum caudatum	wild ginger
107	CASC	*	Campanula scouleri	Scouler's hairbell
108	CHLE		Chrysanthemum leucanthemum	oxeye daisy
109	CIAL		Circaea alpina	alpinae circaea
110	CIEL		Cimicifuga elata	
111	CIVU		Cirsium vulgare	
113	COLA	*	Coptis laciniata	cutleaf golden thread
114	DACA		Daucus carrota	
115	DIFO	*	Dicentra formosa	Pacific bleedingheart
116	DIHO	*	Disporum hookeri	Hooker's fairybells
118	EPILO		Epilobium spp.	willow weed
119	EPWA		Epilobium watsonii	
120	FRVE	*	Fragaria vesca	common strawberry
121	FRVI		Fragaria virginiana	Virginia strawberry
122	GAAP	*	Galium aparine	cleavers
123	GABO		Galium boreale	northern bedstraw
124	GATR	*	Galium triflorum	sweetscented bedstraw
125	GEMA		Geum macrophyllum	largeleaf avens
126	GERO		Geranium rogertianum	
127	GOOB	*	Goodyera oblongifolia	rattlesnake plantain
128	HIAL	*	Hieracium albiflorum	hairy hawkweed
129	HYOC	*	Hydrophyllum occidentale	western waterleaf
130	HYPE		Hypercum perforatum	common St. Johnswort
131	HYRA		Hypochaeris radicata	spotted catsear
133	IRTE	*	Iris tenax	Oregon iris
134	LAMU	*	Lactuca muralis	lettuce
136	LATHY	*	Lathyrus spp.	vetch
137	LIAP	*	Ligusticum apifoliium	lovage
138	LIBO		Linnaea borealis	twinflower
175	MAGR		Madia gracilis	spreading tar-weed
139	MAOR		Marah organus	wild cucumber
140	MOSI	*	Montia siberica	Siberian montia
141	MOUN		Monotropa uniflora	indianpipe
142	NEPA	*	Nemophilia parviflora	small flowered nemophilia
143	OSCH	*	Osmorhiza chilensis	sweet mountain cicely
144	PHACE		Phacelia spp.	phacelia
145	PRVU	*	Prunella vulgaris	common selfheal
146	PYPI		Pyrola picta	whitevein pyrola
147	RUAC		Rumex acetosella	sheep sorrell
148	SACR	*	Sanicula crassicaulis	snakeroot

Appendix 4. (Cont.)

149	SADO	*	Satureja douglasii	yerba buena
150	SEJA	*	Senecio jacobaea	tansy ragwort
151	SMRA	*	Smilacina racemosa	false solomon's seal
152	SMST	*	Smilacina stellata	stary false " "
153	STCR	*	Stellaria crispa	
154	SYRE	*	Synthyrus reniformis	spring queen
155	TEGR	*	Tellima grandiflora	fringecup
156	THOC	*	Thalictrum occidentale	western meadowrue
158	TRLA	*	Trientalis latifolia	western starflower
159	TROV	*	Trillium ovatum	Pacific trillium
80	URTIC		Urtica spp.	nettles
160	VAHE	*	Vancouveria hexandra	inside-out flower
161	VECAC	*	Veratrum californicum caudatum	false helibore
162	VICIA	*	Vicia spp.	vetch
163	VIGL	*	Viola glabella	pioneer violet
164	VISE	*	Viola sempervierns	redwoods violet

GRASSES

166	BRSY	*	Brachypodium sylvaticum	false brome
168	BRVU	*	Bromus vulgaris	Columbia brome
169	CAREX	*	Carex spp.	sedge
170	DAGL		Dactylis glomerata	orchard grass
171	FEOC	*	Festuca occidentalis	western fescue
172	HOLA		Holcus lanatus	velvetgrass

Appendix 5. Complete species percent cover by plot matrix[3].

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
ABGRA[4]	1.0	0.5	0.5	0.5	1.0	3.0	5.0	0.0	2.0	0.0	1.0	0.0	0.0	0.0	1.0
ABGRB	4.0	0.0	0.0	10.0	0.0	0.0	3.0	0.0	15.0	0.0	0.0	0.0	0.0	5.0	0.0
ABGRC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	30.0	0.0	0.0	0.0	0.0	1.0	0.0
ACMAA	0.1	1.0	2.0	0.0	0.1	0.1	3.0	1.0	0.0	1.0	1.0	2.0	2.0	2.0	1.0
ACMAB	4.0	10.0	0.5	0.0	0.0	0.0	3.0	5.0	0.0	0.0	20.0	80.0	12.0	20.0	20.0
ACMAC	15.0	40.0	0.0	0.0	0.0	0.0	0.0	8.0	15.0	5.0	5.0	5.0	0.0	25.0	5.0
ALRUA	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
ALRUB	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ARMEA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.0	0.0
ARMEB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0
CONUA	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0
CONUB	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0
FRLAA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FRLAB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FRLAC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PIPOC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.0	0.0	0.0	0.0	0.0	0.0
PRUNUA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0
PRUNUB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0
PRUNUC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PREMA	0.1	0.1	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0
PREMB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0
PREMC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PSMEA	0.0	0.0	1.0	0.0	0.0	2.0	0.0	0.0	0.0	0.0	1.0	0.5	0.0	0.0	2.0
PSMEB	1.0	0.0	20.0	0.0	0.0	4.0	0.0	2.0	4.0	0.5	0.0	0.0	0.0	0.0	0.0
PSMEC	30.0	40.0	50.0	70.0	70.0	70.0	75.0	50.0	35.0	80.0	60.0	30.0	65.0	40.0	35.0
QUGAA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0
QUGAB	0.0	0.5	0.0	0.0	0.0	2.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
QUGAC	5.0	1.0	25.0	0.0	0.0	0.0	0.0	0.0	5.0	0.0	0.0	0.0	0.0	0.0	0.0
TABRA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TABRB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.0	0.0	0.0	0.0	0.0	0.0	0.0
TABRC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
THPLA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
THPLB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
THPLC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TSHEA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TSHEB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TSHEC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ACCI	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AMAL	0.0	0.0	0.1	3.0	0.0	0.0	0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
BEAQ	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.0	3.0
BENE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
COCO	2.0	2.0	8.0	20.0	2.0	12.0	10.0	1.0	2.0	10.0	35.0	5.0	12.0	12.0	8.0
GASH	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HODI	1.0	0.0	1.0	1.0	0.0	0.5	1.0	0.0	0.0	0.0	0.0	0.0	5.0	0.0	15.0
LOCI	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
LOHI	0.1	0.0	0.5	0.0	0.0	2.0	0.1	0.1	0.1	0.0	0.5	0.0	2.0	1.0	0.5
RHPU	0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.1	0.5	0.0	0.0	0.1	0.0
RHDI	12.0	10.0	4.0	3.0	25.0	15.0	10.0	30.0	2.0	50.0	5.0	0.5	12.0	5.0	2.0

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3 Species listed by acronym names along left hand margin. plot numbers listed along the top of page.

4 The A, B, or C after the four leter acronym refers to the different strata of trees:
A = regeneration (<12' tall)
B = midstory (12-50' tall)
C = overstory (>50'tall)

Appendix 5. (cont.)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
RIDI	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ROSA	0.0	1.0	0.5	5.0	1.0	2.0	1.0	0.5	0.1	0.5	0.0	0.5	3.0	0.5	0.5
RULA	0.0	0.0	0.5	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RULE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RUPA	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	3.0	0.5	0.0	0.0	2.0
RUDI	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.0	0.0	3.0	0.5	0.0
RUUR	2.0	2.0	0.5	10.0	10.0	0.0	8.0	1.0	2.0	10.0	10.0	4.0	10.0	8.0	8.0
SAGL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SYAL	0.1	1.0	0.0	25.0	1.0	5.0	2.0	2.0	8.0	8.0	8.0	7.0	20.0	5.0	3.0
SYMO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
VAPA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
POMU	2.0	2.0	2.0	2.0	5.0	1.0	70.0	1.0	2.0	5.0	50.0	35.0	4.0	45.0	7.0
PTAQ	0.0	1.0	1.0	8.0	0.0	4.0	0.0	8.0	0.0	0.0	0.5	1.0	2.0	0.0	4.0
ACTR	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	2.0	0.0	0.0	0.0
ACRU	0.1	3.0	0.0	20.0	5.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
ADBI	0.1	0.1	1.0	3.0	0.0	0.1	3.0	0.0	1.0	0.5	1.0	2.0	1.0	1.0	3.0
ANDE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ARMA	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.1
ASCA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CASC	0.0	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
COLA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DIFO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.1	0.1
DIHO	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FRVE	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.1
GAAP	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.1
GATR	0.1	0.1	0.5	1.0	2.0	2.0	1.0	0.5	1.0	2.0	1.0	0.1	2.0	1.0	1.0
GOOB	0.1	0.0	0.0	0.1	0.0	0.1	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0
HIAL	0.0	0.0	0.0	0.1	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0
HYOC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
IRTE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LAMU	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LATHY	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1
LIAP	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MOSI	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0	0.0	0.0	0.5	1.0	0.0	0.5	0.5
NEPA	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.1
OSCH	0.1	0.1	1.0	1.0	1.0	2.0	0.1	0.0	1.0	5.0	2.0	1.0	2.0	2.0	1.0
PRVU	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
SACR	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.1	1.0	0.0	0.0	0.1	0.0
SADO	0.1	0.0	0.1	0.0	3.0	2.0	0.0	0.5	0.0	2.0	0.5	0.0	1.0	1.0	0.0
SEJA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SMRA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.5	0.0	0.0	0.1
SMST	0.0	0.0	0.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0
STCR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SYRE	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.5
TEGR	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.5	0.0	0.5	0.1
THOC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5
TRLA	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	2.0	2.0	1.0
TROV	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.0	0.0	0.1	0.0
VAHE	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0
VECAC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
VICIA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
VIGL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	5.0	0.0	7.0
VISE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BRSY	50.0	15.0	55.0	2.0	60.0	60.0	15.0	80.0	35.0	5.0	1.0	1.0	2.0	1.0	1.0
BRVU	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.5	0.0	0.0
CAREX	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.5	0.0	0.0	0.0	2.0
FEOC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Appendix 5. (cont.)

	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
ABGRA	0.0	0.5	2.0	0.0	0.0	0.5	0.0	0.5	3.0	15.0	4.0	1.0	0.0	1.0	5.0
ABGRB	0.0	0.0	0.0	1.0	0.0	0.0	0.0	2.0	7.0	15.0	17.0	0.0	0.0	5.0	25.0
ABGRC	5.0	0.0	3.0	0.0	0.0	30.0	0.0	50.0	20.0	20.0	3.0	0.0	0.0	7.0	5.0
ACMAA	1.0	0.5	1.0	1.0	2.0	0.1	0.0	0.5	1.0	0.0	1.0	4.0	0.1	2.0	0.1
ACMAB	4.0	3.0	10.0	5.0	0.0	4.0	40.0	0.0	10.0	20.0	0.0	2.0	0.0	3.0	0.0
ACMAC	3.0	0.0	30.0	70.0	75.0	35.0	0.0	25.0	10.0	15.0	40.0	3.0	40.0	2.0	15.0
ALRUA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ALRUB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ARMEA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ARMEB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CONUA	0.0	0.0	0.5	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.0	0.1	0.0	0.0
CONUB	0.0	0.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FRLAA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FRLAB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0
FRLAC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PIPOC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PRUNUA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
PRUNUB	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PRUNUC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PREMA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PREMB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PREMC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PSMEA	0.0	0.0	0.0	0.5	1.0	0.5	0.5	0.0	0.0	0.0	0.0	2.0	0.0	0.0	0.0
PSMEB	0.0	0.0	0.0	0.0	5.0	0.0	0.0	0.0	0.0	2.0	0.0	0.0	0.0	0.0	0.0
PSMEC	70.0	75.0	20.0	50.0	35.0	20.0	25.0	20.0	55.0	40.0	60.0	65.0	35.0	70.0	60.0
QUGAA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.1
QUGAB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
QUGAC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	1.0	0.0
TABRA	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TABRB	0.0	0.0	0.0	0.0	0.0	3.0	0.0	2.0	10.0	0.0	0.0	0.0	0.0	0.0	0.0
TABRC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
THPLA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
THPLB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
THPLC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TSHEA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TSHEB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TSHEC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ACCI	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0	1.0	0.0	0.0	0.0	0.0
AMAL	0.5	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0
BEAQ	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0
BENE	0.0	0.5	0.0	0.0	0.0	3.0	3.0	15.0	2.0	0.0	0.0	1.0	80.0	0.0	2.0
COCO	40.0	5.0	5.0	5.0	5.0	7.0	40.0	5.0	10.0	4.0	8.0	8.0	4.0	5.0	3.0
GASH	0.0	0.0	0.0	0.0	0.0	20.0	40.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HODI	0.0	0.0	0.0	1.0	0.0	6.0	3.0	1.0	1.0	0.0	5.0	0.0	2.0	5.0	2.0
LOCI	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.0
LOHI	0.5	0.0	0.0	0.5	0.0	0.0	0.0	0.1	0.5	0.5	0.0	0.0	0.0	0.0	0.0
RHPU	0.1	2.0	2.0	0.0	0.0	0.0	0.0	0.1	0.0	1.0	0.0	0.1	0.0	0.0	0.0
RHDI	20.0	2.0	18.0	25.0	0.0	0.0	0.5	0.0	1.0	30.0	40.0	5.0	0.0	15.0	0.0
RIDI	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0
ROSA	1.0	1.0	1.0	1.0	0.5	3.0	2.0	2.0	1.0	0.1	2.0	3.0	2.0	2.0	4.0
RULA	0.0	0.1	0.5	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RULE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RUPA	0.0	0.0	0.0	0.0	4.0	0.0	0.0	0.0	0.1	0.1	1.0	0.0	0.5	0.0	0.1
RUDI	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RUUR	20.0	3.0	3.0	10.0	1.0	1.0	1.0	0.1	2.0	2.0	5.0	5.0	2.0	5.0	2.0
SAGL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SYAL	10.0	5.0	15.0	5.0	1.0	3.0	1.0	12.0	2.0	2.0	2.0	2.0	2.0	2.0	0.1
SYMO	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
VAPA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Appendix 5. (cont.)

	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
POMU	20.0	45.0	55.0	35.0	35.0	20.0	15.0	10.0	3.0	3.0	2.0	65.0	20.0	3.0	2.0
PTAQ	0.1	2.0	0.5	0.0	0.5	0.0	0.0	0.0	1.0	0.0	0.1	0.0	1.0	1.0	0.0
ACTR	0.1	2.0	2.0	3.0	8.0	5.0	4.0	3.0	4.0	0.0	7.0	4.0	0.1	1.0	3.0
ACRU	0.0	2.0	0.0	0.0	0.5	0.0	0.0	0.0	2.0	0.0	20.0	0.0	2.0	0.0	0.0
ADBI	2.0	0.5	5.0	3.0	4.0	2.0	1.0	3.0	3.0	2.0	5.0	3.0	0.5	2.0	6.0
ANDE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.5	0.0	0.5	0.0	0.0	1.0	1.0
ARMA	2.0	0.5	0.0	3.0	0.0	0.5	1.0	0.0	1.0	0.0	1.0	0.0	0.5	1.0	2.0
ASCA	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CASC	0.1	0.0	0.0	0.0	0.1	1.0	0.1	0.0	0.0	0.0	0.1	0.0	0.1	0.5	1.0
COLA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DIFO	0.0	0.0	0.5	0.5	0.5	0.1	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0
DIHO	0.0	0.1	0.0	0.0	2.0	2.0	1.0	0.5	3.0	0.0	3.0	0.0	2.0	3.0	2.0
FRVE	1.0	0.1	0.5	0.5	0.0	0.0	0.0	0.0	1.0	0.1	1.0	0.5	0.1	0.1	0.0
GAAP	0.1	0.5	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
GATR	2.0	2.0	3.0	3.0	1.0	1.0	0.0	0.5	2.0	0.5	0.0	2.0	0.5	1.0	1.0
GOOB	0.1	0.1	0.1	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.1
HIAL	0.1	0.0	0.0	0.0	0.0	1.0	0.1	1.0	0.5	0.0	0.0	0.5	0.0	0.0	0.1
HYOC	1.0	1.0	0.1	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IRTE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LAMU	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.0	0.0	0.0	0.0
LATHY	0.1	0.0	0.0	0.1	0.0	0.5	0.0	0.0	0.5	0.0	0.5	0.0	0.0	1.0	0.1
LIAP	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	10.0	4.0
MOSI	0.1	2.0	3.0	3.0	2.0	0.5	0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
NEPA	0.1	0.1	0.0	0.1	0.1	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.1	0.0
OSCH	3.0	2.0	3.0	3.0	2.0	2.0	1.0	3.0	2.0	1.0	0.5	1.0	0.1	1.0	0.5
PRVU	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SACR	0.1	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SADO	3.0	0.5	0.1	0.0	0.0	0.0	0.0	3.0	2.0	0.5	0.5	0.5	0.0	0.0	0.0
SEJA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0
SMRA	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.1	0.0
SMST	0.0	25.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
STCR	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SYRE	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.5	0.0	0.0	1.0	0.0
TEGR	0.0	0.0	0.1	0.0	2.0	0.0	0.1	0.0	0.1	0.0	0.0	0.0	1.0	0.0	0.0
THOC	0.0	3.0	0.0	0.0	0.5	0.0	0.0	0.0	1.0	0.0	2.0	0.0	1.0	5.0	2.0
TRLA	0.0	0.0	3.0	0.0	3.0	2.0	1.0	1.0	1.0	0.0	2.0	2.0	0.1	2.0	2.0
TROV	0.1	0.0	0.1	0.1	0.1	0.0	0.1	0.0	0.0	0.0	0.1	0.0	0.1	0.0	0.1
VAHE	0.0	0.0	0.0	0.0	0.0	1.0	1.0	5.0	10.0	0.0	3.0	8.0	2.0	7.0	3.0
VECAC	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.5	0.0	0.0	0.1	0.0	0.0	0.0	0.1
VICIA	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
VIGL	0.1	15.0	3.0	1.0	25.0	3.0	0.0	0.5	1.0	0.0	2.0	0.0	0.0	2.0	2.0
VISE	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BRSY	1.0	1.0	2.0	2.0	1.0	5.0	0.5	3.0	30.0	20.0	25.0	2.0	0.5	2.0	2.0
BRVU	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CAREX	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FEOC	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.5	0.0	0.0	0.0	0.0	0.0	0.1

Appendix 5. (cont.)

	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
ABGRA	0.5	1.0	1.0	0.0	0.0	0.5	0.5	0.5	1.0	5.0	0.0	0.0	0.5	0.0	3.0
ABGRB	2.0	3.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	3.0	0.0	0.0
ABGRC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.0	0.0	0.0	0.0	0.0
ACMAA	1.0	0.1	2.0	1.0	0.0	3.0	0.5	3.0	4.0	5.0	1.0	0.5	1.0	2.0	5.0
ACMAB	3.0	0.0	10.0	17.0	0.0	6.0	1.0	35.0	3.0	2.0	4.0	30.0	0.0	0.0	40.0
ACMAC	0.0	20.0	12.0	25.0	0.0	0.0	0.0	1.0	40.0	0.0	0.0	30.0	0.0	0.0	8.0
ALRUA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ALRUB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ARMEA	0.0	0.0	0.5	0.0	0.0	0.0	1.0	0.0	0.0	3.0	0.0	0.0	0.0	0.0	0.0
ARMEB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CONUA	0.0	0.0	2.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	1.0	0.0	0.0	0.0	0.0
CONUB	0.0	0.0	0.0	0.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FRLAA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FRLAB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FRLAC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PIPOC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PRUNUA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0
PRUNUB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PRUNUC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PREMA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PREMB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PREMC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PSMEA	0.0	0.0	2.0	0.0	0.0	0.0	3.0	0.0	0.0	3.0	0.5	0.5	2.0	0.0	0.0
PSMEB	12.0	0.0	0.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	6.0	2.0	4.0
PSMEC	80.0	55.0	75.0	65.0	95.0	80.0	75.0	75.0	55.0	80.0	65.0	55.0	60.0	65.0	60.0
QUGAA	0.5	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.5	0.0	0.0
QUGAB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0
QUGAC	1.0	10.0	0.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	20.0	0.0	0.0
TABRA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TABRB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TABRC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
THPLA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
THPLB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
THPLC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TSHEA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TSHEB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TSHEC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ACCI	0.0	0.0	0.0	0.0	40.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AMAL	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0
BEAQ	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.1	0.0	0.0	0.0
BENE	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
COCO	3.0	4.0	7.0	6.0	45.0	2.0	70.0	3.0	4.0	25.0	8.0	20.0	15.0	30.0	3.0
GASH	0.0	0.0	0.0	0.0	8.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HODI	0.0	0.0	0.5	1.0	3.0	0.5	2.0	2.0	0.0	4.0	0.5	0.0	1.0	0.0	0.5
LOCI	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.5	2.0	0.0	0.0	0.1	0.0	0.0
LOHI	0.0	0.0	0.5	0.0	0.0	0.5	0.0	1.0	1.0	1.0	0.0	0.0	4.0	0.0	0.0
RHPU	0.0	0.0	0.5	0.0	0.0	0.1	0.1	0.1	0.5	0.1	0.0	0.0	0.0	2.0	0.0
RHDI	1.0	5.0	25.0	1.0	0.0	0.5	0.1	7.0	10.0	12.0	10.0	5.0	35.0	3.0	2.0
RIDI	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
ROSA	0.1	0.1	2.0	3.0	3.0	2.0	8.0	0.0	0.0	2.0	0.0	0.5	1.0	0.0	2.0
RULA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5
RULE	0.0	0.0	0.5	0.0	0.0	0.0	0.0	5.0	0.0	0.0	0.0	0.0	0.0	5.0	2.0
RUPA	0.0	0.0	0.0	0.1	13.0	2.0	15.0	0.0	7.0	15.0	0.0	3.0	0.0	1.0	0.0
RUDI	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.0	2.0
RUUR	3.0	2.0	35.0	17.0	3.0	6.0	5.0	35.0	20.0	35.0	12.0	7.0	0.0	65.0	9.0
SAGL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.0	0.0
SYAL	0.1	0.0	0.1	15.0	15.0	3.0	10.0	12.0	4.0	5.0	4.0	25.0	1.0	0.0	10.0
SYMO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0
VAPA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Appendix 5. (cont.)

	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
POMU	2.0	8.0	3.0	20.0	12.0	10.0	2.0	10.0	75.0	8.0	85.0	12.0	1.0	30.0	7.0
PTAQ	0.0	0.0	2.0	0.5	3.0	3.0	0.5	0.0	1.0	10.0	0.0	7.0	1.0	3.0	0.5
ACTR	0.5	0.0	1.0	0.5	5.0	1.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ACRU	0.0	0.0	0.0	0.0	3.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0
ADBI	5.0	25.0	3.0	4.0	3.0	3.0	2.0	1.0	0.5	0.5	2.0	3.0	2.0	0.1	1.0
ANDE	1.0	0.1	0.1	0.5	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ARMA	0.1	0.1	2.0	0.5	0.5	1.0	2.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.5
ASCA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CASC	0.0	0.0	0.0	0.1	1.0	2.0	1.0	0.5	0.0	2.0	0.0	0.5	0.0	0.0	0.0
COLA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DIFO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DIHO	0.0	0.0	0.0	0.0	3.0	2.0	0.5	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0
FRVE	0.0	0.0	2.0	2.0	0.0	0.5	0.5	0.5	0.1	0.5	0.0	0.0	0.0	0.0	0.0
GAAP	0.0	0.0	0.0	0.1	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0
GATR	3.0	3.0	3.0	2.0	2.0	2.0	1.0	1.0	2.0	2.0	3.0	2.0	3.0	6.0	2.0
GOOB	0.5	0.5	0.0	0.5	0.0	0.1	0.1	0.0	0.1	0.0	0.0	0.0	2.0	0.0	0.1
HIAL	0.1	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.1	0.0	0.1	0.0	0.5	0.1	0.0
HYOC	0.0	0.0	0.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IRTE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LAMU	5.0	2.0	1.0	0.0	0.0	0.0	1.0	0.0	0.5	0.0	1.0	0.0	0.0	4.0	2.0
LATHY	0.0	0.0	0.0	0.1	0.0	1.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LIAP	0.0	0.0	0.1	0.1	1.0	0.5	1.0	0.0	0.0	0.0	0.0	1.0	0.1	0.0	0.0
MOSI	0.1	0.1	0.1	10.0	0.0	0.5	0.5	0.0	0.5	0.0	1.0	0.0	0.0	0.1	0.0
NEPA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OSCH	2.0	1.0	1.0	3.0	0.1	3.0	3.0	2.0	2.0	1.0	2.0	2.0	2.0	3.0	3.0
PRVU	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SACR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SADO	0.1	0.0	0.0	3.0	0.1	0.5	0.0	1.0	1.0	1.0	3.0	0.0	2.0	0.0	2.0
SEJA	0.1	0.0	0.0	0.0	0.1	0.0	0.5	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
SMRA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SMST	0.0	0.0	0.0	0.5	0.0	0.5	3.0	1.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0
STCR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
SYRE	0.0	0.0	0.5	0.0	0.0	2.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TEGR	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
THOC	0.0	0.0	0.0	0.5	0.5	1.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TRLA	0.0	0.0	0.1	2.0	3.0	2.0	1.0	2.0	1.0	3.0	0.0	2.0	0.0	0.0	2.0
TROV	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.0
VAHE	0.1	0.1	7.0	1.0	1.0	4.0	22.0	0.0	0.0	0.0	0.0	7.0	0.0	0.0	0.0
VECAC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
VICIA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
VIGL	0.0	0.0	0.0	0.0	0.1	2.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
VISE	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BRSY	50.0	55.0	20.0	2.0	3.0	2.0	4.0	2.0	0.1	2.0	0.5	45.0	70.0	0.5	0.5
BRVU	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
CAREX	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0
FEOC	0.0	0.1	0.0	0.0	0.5	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0

Appendix 5. (cont.)

	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
ABGRA	4.0	0.1	3.0	0.5	3.0	3.0	2.0	3.0	2.0	0.5	0.5	2.0	1.0	4.0	0.0
ABGRB	0.0	1.0	0.0	2.0	0.0	0.0	0.0	5.0	0.0	0.0	0.0	3.0	2.0	2.0	3.0
ABGRC	0.0	10.0	15.0	0.0	0.0	0.0	3.0	0.0	0.0	0.0	3.0	0.0	0.0	0.0	0.0
ACMAA	5.0	2.0	5.0	3.0	1.0	3.0	8.0	2.0	3.0	10.0	3.0	2.0	4.0	2.0	0.0
ACMAB	12.0	3.0	0.0	3.0	0.0	0.0	0.0	30.0	30.0	5.0	7.0	0.5	7.0	4.0	0.0
ACMAC	0.0	15.0	0.0	0.0	0.0	0.0	6.0	55.0	0.0	0.0	0.0	7.0	5.0	4.0	0.0
ALRUA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ALRUB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ARMEA	0.0	0.0	0.5	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ARMEB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CONUA	0.1	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CONUB	0.0	5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FRLAA	0.1	0.0	0.0	0.0	0.0	2.0	0.0	0.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0
FRLAB	0.0	0.0	0.0	0.0	0.0	2.0	0.0	0.0	3.0	0.0	0.0	0.0	0.0	0.0	0.0
FRLAC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PIPOC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PRUNUA	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PRUNUB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PRUNUC	0.0	3.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PREMA	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PREMB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PREMC	0.0	0.0	0.0	0.0	0.0	4.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PSMEA	11.0	0.1	0.1	0.5	0.0	0.0	0.5	0.0	0.0	0.5	0.0	0.0	0.1	0.0	0.0
PSMEB	8.0	0.0	1.0	0.0	3.0	0.0	3.0	0.0	0.0	4.0	0.0	0.0	0.0	0.0	5.0
PSMEC	65.0	60.0	55.0	90.0	85.0	65.0	80.0	35.0	65.0	75.0	80.0	90.0	50.0	80.0	50.0
QUGAA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	2.0	0.0	0.0	0.1	0.0	0.0
QUGAB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
QUGAC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	35.0	0.0	0.0
TABRA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TABRB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TABRC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
THPLA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
THPLB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
THPLC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TSHEA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TSHEB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TSHEC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ACCI	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AMAL	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.1	0.0	0.1	0.0	0.1	0.0
BEAQ	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.1	1.0
BENE	0.0	2.0	0.0	0.0	0.5	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
COCO	2.0	2.0	10.0	2.0	7.0	4.0	7.0	8.0	35.0	3.0	17.0	2.0	6.0	2.0	6.0
GASH	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HODI	0.0	0.0	0.5	0.0	4.0	1.0	0.0	0.0	1.0	0.1	0.5	5.0	9.0	2.0	10.0
LOCI	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LOHI	2.0	0.0	10.0	7.0	0.0	1.0	1.0	0.1	4.0	0.0	2.0	2.0	0.0	8.0	0.0
RHPU	0.5	0.1	0.1	0.1	0.1	0.0	2.0	0.1	0.1	0.0	0.0	0.0	0.5	0.1	0.0
RHDI	70.0	0.0	2.0	20.0	0.5	7.0	1.0	0.5	5.0	5.0	9.0	4.0	35.0	14.0	1.0
RIDI	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ROSA	3.0	0.0	2.0	1.0	1.0	0.5	0.1	3.0	0.1	1.0	1.0	1.0	0.1	4.0	2.0
RULA	0.0	0.0	0.5	1.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RULE	2.0	0.0	2.0	1.0	0.5	4.0	0.5	0.0	0.0	0.1	2.0	2.0	0.0	0.0	0.0
RUPA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.1	0.0	0.1	0.0	0.0	0.0	0.0
RUDI	0.0	0.0	1.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RUUR	10.0	0.1	25.0	3.0	7.0	80.0	15.0	4.0	7.0	12.0	25.0	10.0	11.0	0.0	3.0
SAGL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SYAL	4.0	2.0	8.0	3.0	3.0	5.0	2.0	3.0	15.0	3.0	2.0	3.0	10.0	12.0	8.0
SYMO	0.0	0.0	0.0	0.0	3.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0
VAPA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
POMU	3.0	5.0	20.0	20.0	75.0	25.0	5.0	15.0	45.0	4.0	35.0	20.0	22.0	8.0	20.0

Appendix 5. (cont.)

	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
PTAQ	0.0	3.0	8.0	10.0	4.0	2.0	6.0	0.5	10.0	9.0	3.0	0.0	4.0	0.0	3.0
ACTR	0.0	0.1	0.0	0.0	1.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
ACRU	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ADBI	0.5	0.0	4.0	2.0	2.0	1.0	2.0	6.0	0.5	1.0	1.0	2.0	10.0	6.0	2.0
ANDE	0.0	0.1	0.5	0.1	0.1	0.0	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.1
ARMA	0.0	0.5	0.0	0.0	0.5	0.0	0.0	8.0	0.5	1.0	1.0	1.0	0.0	10.0	5.0
ASCA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CASC	0.0	0.0	0.1	0.0	2.0	0.0	0.0	0.0	0.5	0.0	0.0	0.5	2.0	0.0	0.5
COLA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DIFO	0.0	0.0	0.0	0.0	8.0	0.0	0.0	0.0	0.0	0.0	12.0	0.0	0.0	0.0	0.0
DIHO	0.0	2.0	0.0	0.0	2.0	0.0	0.0	6.0	0.0	0.0	0.0	0.0	4.0	0.1	0.0
FRVE	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	2.0	3.0	0.5	2.0	6.0	3.0	0.5
GAAP	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0
GATR	2.0	1.0	4.0	8.0	3.0	3.0	7.0	4.0	2.0	3.0	2.0	4.0	10.0	15.0	5.0
GOOB	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.5	0.0	1.0	0.1	0.1	0.1
HIAL	0.0	0.0	0.1	0.1	0.5	0.1	0.0	0.1	0.1	0.1	0.1	0.1	0.0	0.0	1.0
HYOC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IRTE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LAMU	0.0	0.0	0.1	0.0	0.0	0.0	20.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0
LATHY	0.0	0.1	0.0	0.1	0.1	0.0	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.0	0.0
LIAP	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	2.0	0.1	1.0
MOSI	0.0	0.0	0.0	0.5	0.5	0.5	0.1	4.0	0.0	0.1	3.0	3.0	3.0	3.0	4.0
NEPA	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OSCH	3.0	0.0	4.0	5.0	0.5	1.0	2.0	3.0	3.0	3.0	2.0	1.0	10.0	8.0	2.0
PRVU	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
SACR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SADO	3.0	0.0	5.0	1.0	3.0	6.0	0.0	0.0	1.0	1.0	3.0	2.0	8.0	7.0	3.0
SEJA	0.0	0.0	0.1	0.1	0.0	0.1	0.1	0.0	0.0	0.0	0.5	0.5	0.0	0.0	0.0
SMRA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5
SMST	0.0	0.0	0.0	0.0	4.0	7.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	3.0
STCR	0.0	0.0	0.0	0.0	0.5	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
SYRE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.1
TEGR	0.0	0.0	0.0	0.0	1.0	0.0	0.0	2.0	0.0	0.0	0.0	0.1	0.5	0.1	0.1
THOC	0.0	0.0	0.0	0.0	0.5	0.0	0.0	6.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TRLA	3.0	10.0	5.0	6.0	3.0	2.0	4.0	2.0	3.0	4.0	0.5	0.0	0.0	5.0	1.0
TROV	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
VAHE	0.0	1.0	0.0	0.5	1.0	0.0	2.0	25.0	0.0	0.1	0.0	0.0	2.0	1.0	0.0
VECAC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
VICIA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
VIGL	0.0	0.5	0.0	0.0	2.0	0.0	0.0	5.0	0.0	0.0	0.0	0.0	5.0	0.0	0.0
VISE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BRSY	2.0	1.0	1.0	4.0	0.1	1.0	5.0	2.0	1.0	8.0	2.0	3.0	2.0	2.0	1.0
BRVU	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CAREX	0.0	0.0	0.1	0.0	0.0	0.5	0.0	0.1	0.0	0.5	1.0	0.0	0.0	0.0	1.0
FEOC	0.0	1.0	0.0	0.1	0.1	0.0	0.0	1.0	0.0	0.0	0.0	0.0	4.0	3.0	0.1

Appendix 5. (cont.)

	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
ABGRA	0.0	2.0	0.0	9.0	0.0	0.1	0.5	0.0	0.5	0.0	0.0	0.1	0.1	2.0	0.0
ABGRB	0.0	3.0	0.0	20.0	0.0	0.0	0.0	5.0	0.0	0.0	0.0	0.0	3.0	7.0	2.0
ABGRC	0.0	0.0	0.0	7.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.0	0.0
ACMAA	0.5	0.0	0.0	0.0	2.0	4.0	1.0	2.0	1.0	3.0	1.0	2.0	0.0	0.1	4.0
ACMAB	5.0	0.0	0.0	0.0	10.0	15.0	1.0	2.0	0.0	0.0	2.0	0.0	0.0	0.0	15.0
ACMAC	20.0	0.0	0.0	70.0	30.0	0.0	50.0	0.0	0.0	0.0	27.0	20.0	3.0	25.0	13.0
ALRUA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ALRUB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ARMEA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0
ARMEB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CONUA	2.0	3.0	0.0	0.0	4.0	3.0	0.0	6.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0
CONUB	0.0	12.0	0.0	0.0	0.0	0.0	0.0	25.0	0.0	0.0	0.0	0.0	2.0	12.0	0.0
FRLAA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0
FRLAB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FRLAC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PIPOC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PRUNUA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PRUNUB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PRUNUC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	2.0	0.0	0.0	0.0
PREMA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PREMB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PREMC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PSMEA	0.0	0.5	0.0	0.0	5.0	1.0	0.0	0.5	0.0	0.0	0.0	0.0	0.1	0.5	0.0
PSMEB	3.0	0.0	3.0	0.0	10.0	5.0	0.0	0.0	2.0	1.0	1.0	0.0	0.0	0.0	0.0
PSMEC	45.0	60.0	80.0	10.0	55.0	55.0	40.0	75.0	60.0	45.0	60.0	65.0	70.0	40.0	68.0
QUGAA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
QUGAB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
QUGAC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0
TABRA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TABRB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12.0	0.0	0.0
TABRC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
THPLA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.0	0.0	0.0	0.0	0.0	0.0
THPLB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.0	0.0	0.0	0.0	0.0	0.0
THPLC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TSHEA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TSHEB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TSHEC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ACCI	0.0	4.0	75.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	75.0	30.0	0.0
AMAL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
BEAQ	0.0	0.0	0.0	0.0	0.1	0.0	0.5	3.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0
BENE	0.0	35.0	0.0	0.0	0.0	0.0	0.0	3.0	0.0	0.0	0.0	0.0	8.0	0.1	0.0
COCO	25.0	11.0	25.0	4.0	20.0	15.0	6.0	15.0	5.0	2.0	7.0	2.0	3.0	15.0	0.0
GASH	0.0	6.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	30.0	10.0	0.0
HODI	0.0	7.0	0.0	0.0	0.0	0.0	1.0	1.0	0.1	0.5	7.0	0.0	5.0	2.0	0.0
LOCI	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.1
LOHI	0.0	0.0	0.0	0.0	0.1	3.0	0.0	0.0	2.0	1.0	2.0	2.0	1.0	1.0	0.0
RHPU	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.1	0.1	0.5	2.0	0.1	0.1
RHDI	0.0	0.0	0.0	0.0	7.0	16.0	0.0	0.0	0.0	0.5	0.5	1.0	0.0	0.1	0.1
RIDI	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
ROSA	6.0	8.0	4.0	0.1	2.0	2.0	1.0	2.0	1.0	0.1	1.0	0.5	2.0	3.0	0.1
RULA	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RULE	0.0	0.0	0.0	0.0	0.5	0.5	0.0	0.5	0.0	4.0	0.0	0.0	0.0	0.0	0.1
RUPA	5.0	9.0	2.0	0.5	0.1	0.5	0.5	0.5	2.0	1.0	0.5	0.1	7.0	0.1	0.0
RUDI	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RUUR	2.0	6.0	6.0	4.0	10.0	12.0	12.0	0.0	15.0	4.0	6.0	7.0	5.0	4.0	3.0
SAGL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SYAL	2.0	15.0	1.0	2.0	2.0	3.0	10.0	5.0	3.0	0.0	7.0	0.0	0.5	0.0	0.0
SYMO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	1.0	0.0	0.0	0.0
VAPA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0

Appendix 5. (cont.)

	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
POMU	1.0	6.0	3.0	40.0	40.0	30.0	10.0	15.0	55.0	83.0	32.0	5.0	4.0	6.0	80.0
PTAQ	15.0	6.0	0.0	2.0	0.0	0.0	5.0	2.0	9.0	0.0	5.0	2.0	1.0	1.0	0.0
ACTR	5.0	5.0	10.0	10.0	4.0	6.0	4.0	55.0	1.0	0.0	0.0	0.0	0.0	0.5	0.0
ACRU	3.0	2.0	0.0	0.1	0.0	0.0	0.0	3.0	0.5	0.0	0.0	0.0	0.0	0.1	0.0
ADBI	7.0	2.0	0.1	3.0	0.1	1.0	6.0	2.0	2.0	1.0	3.0	12.0	0.1	0.5	0.5
ANDE	1.0	0.1	1.0	3.0	0.0	0.0	2.0	0.0	0.0	0.1	0.1	0.0	0.0	0.1	0.1
ARMA	6.0	0.0	0.0	0.0	0.1	0.0	0.5	0.5	0.5	0.0	6.0	15.0	0.1	1.0	0.0
ASCA	0.0	0.0	0.0	5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CASC	0.5	1.0	1.0	0.0	2.0	0.0	1.0	0.1	1.0	2.0	2.0	0.5	1.0	2.0	0.0
COLA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DIFO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
DIHO	10.0	3.0	12.0	8.0	0.1	0.0	3.0	4.0	2.0	0.0	0.0	0.0	0.1	0.1	0.0
FRVE	0.0	0.0	0.0	0.0	1.0	1.0	0.5	0.0	0.0	0.1	0.5	0.0	0.1	0.1	0.0
GAAP	0.0	0.0	0.0	0.0	0.0	1.0	0.1	0.0	0.1	0.0	0.0	3.0	0.0	2.0	1.0
GATR	3.0	1.0	1.0	3.0	2.0	5.0	2.0	2.0	2.0	2.0	1.0	0.0	1.0	1.0	1.0
GOOB	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.5	0.1	0.1	0.1	0.0
HIAL	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.5	0.1	0.0	0.1	0.1	0.0
HYOC	0.0	0.0	0.0	4.0	0.1	1.0	0.5	0.0	0.5	0.0	0.1	0.0	0.0	0.0	0.0
IRTE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0
LAMU	0.0	0.0	0.0	0.0	20.0	3.0	1.0	1.0	0.0	0.0	0.0	38.0	0.0	0.0	0.1
LATHY	0.5	0.0	0.0	0.0	0.1	0.0	1.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0
LIAP	0.0	2.0	0.0	0.0	2.0	0.0	1.0	2.0	0.1	0.0	5.0	0.5	0.0	0.0	0.1
MOSI	0.0	0.0	0.0	2.0	0.0	0.5	1.0	0.5	1.0	0.0	1.0	3.0	0.0	0.0	2.0
NEPA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
OSCH	2.0	0.0	2.0	3.0	2.0	2.0	2.0	0.5	2.0	1.0	5.0	2.0	0.1	0.0	2.0
PRVU	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SACR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SADO	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	1.0	0.1	1.0	0.0	0.0
SEJA	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.1	0.0	0.1	0.0	0.1	0.0
SMRA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.0
SMST	0.0	6.0	0.0	0.1	0.1	0.0	0.0	0.1	0.0	0.0	1.0	0.1	3.0	0.0	0.0
STCR	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.5
SYRE	0.1	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
TEGR	0.0	0.0	0.0	3.0	0.0	0.1	2.0	1.0	0.0	0.5	0.1	0.0	0.0	0.0	4.0
THOC	12.0	4.0	8.0	6.0	0.0	0.0	4.0	3.0	8.0	0.0	0.0	0.1	0.0	0.1	0.0
TRLA	0.1	0.1	1.0	0.0	2.0	0.0	0.5	2.0	1.0	0.0	2.0	0.0	1.0	2.0	0.5
TROV	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.5	0.0	0.1	0.0	0.1	0.1	0.1
VAHE	30.0	15.0	15.0	20.0	3.0	15.0	20.0	5.0	16.0	0.0	0.1	0.0	0.5	0.1	0.0
VECAC	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.0
VICIA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
VIGL	8.0	5.0	7.0	0.0	0.0	1.0	3.0	3.0	2.0	0.0	0.0	1.0	0.0	0.1	0.0
VISE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0
BRSY	6.0	2.0	3.0	1.0	4.0	3.0	3.0	3.0	6.0	0.5	3.0	25.0	1.0	2.0	0.5
BRVU	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CAREX	0.0	1.0	0.0	2.0	0.0	0.1	0.0	0.0	0.1	0.0	2.0	0.0	0.1	0.0	0.0
FEOC	1.0	0.0	2.0	2.0	2.0	0.1	0.0	0.1	0.1	0.1	1.0	0.1	0.1	0.0	0.1

Appendix 5. (cont.)

	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90
ABGRA	4.0	0.0	5.0	4.0	5.0	3.0	4.0	0.5	2.0	0.0	0.0	0.1	2.0	3.0	2.0
ABGRB	0.0	0.0	35.0	0.0	2.0	5.0	0.0	0.0	6.0	0.0	0.0	0.0	0.0	7.0	0.0
ABGRC	20.0	0.0	0.0	7.0	0.0	0.0	0.0	0.0	30.0	0.0	0.0	0.0	0.0	0.0	0.0
ACMAA	6.0	0.1	3.0	1.0	3.0	0.0	5.0	30.0	0.1	2.0	5.0	0.1	2.0	0.5	0.5
ACMAB	15.0	1.0	35.0	20.0	1.0	0.0	5.0	3.0	8.0	15.0	55.0	15.0	0.0	8.0	2.0
ACMAC	2.0	35.0	0.0	15.0	8.0	35.0	0.0	25.0	50.0	15.0	0.0	20.0	38.0	0.1	75.0
ALRUA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ALRUB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ARMEA	0.0	0.0	0.0	0.1	0.5	0.0	0.5	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.5
ARMEB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CONUA	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0	0.0	2.0	0.0	3.0	0.0	0.0	0.0
CONUB	0.0	3.0	2.0	2.0	0.0	4.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FRLAA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5
FRLAB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FRLAC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PIPOC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PRUNUA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.0	0.0
PRUNUB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PRUNUC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PREMA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0
PREMB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PREMC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PSMEA	0.0	0.0	1.0	0.0	0.0	0.0	3.0	0.0	0.0	0.0	0.0	0.0	7.0	4.0	0.0
PSMEB	3.0	0.0	0.0	10.0	5.0	0.0	0.0	0.0	0.0	0.0	5.0	0.0	12.0	1.0	0.0
PSMEC	50.0	65.0	38.0	60.0	80.0	70.0	80.0	20.0	20.0	80.0	55.0	65.0	55.0	85.0	45.0
QUGAA	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.5	0.1	0.1
QUGAB	0.0	0.0	0.0	4.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	8.0	0.5	0.0
QUGAC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0	0.0	0.0	0.0	5.0	0.0
TABRA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0
TABRB	0.0	0.0	0.0	0.0	0.0	4.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TABRC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
THPLA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
THPLB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
THPLC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TSHEA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TSHEB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TSHEC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ACCI	0.0	0.0	0.0	0.0	0.0	25.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AMAL	0.0	0.0	0.1	0.1	0.0	0.1	0.0	0.1	0.0	0.0	0.1	0.1	0.1	0.0	0.1
BEAQ	0.5	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.1	0.0	0.5
BENE	0.0	0.0	0.5	0.0	0.0	60.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
COCO	12.0	1.0	7.0	25.0	12.0	8.0	20.0	0.0	20.0	22.0	50.0	3.0	3.0	8.0	10.0
GASH	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HODI	0.5	0.0	4.0	0.0	2.0	1.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	5.0
LOCI	0.0	0.0	0.1	0.0	0.0	0.1	0.0	2.0	0.0	0.1	0.0	0.0	0.0	0.0	0.1
LOHI	0.0	0.0	0.0	4.0	0.0	0.0	0.0	0.0	0.0	1.0	0.5	0.1	0.1	1.0	0.0
RHPU	2.0	1.0	0.0	0.1	0.1	0.0	0.0	0.5	0.5	0.1	0.5	0.1	0.1	0.1	0.1
RHDI	45.0	1.0	0.5	10.0	30.0	0.0	27.0	2.0	2.0	15.0	5.0	6.0	10.0	15.0	20.0
RIDI	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ROSA	0.0	0.0	3.0	3.0	1.0	3.0	2.0	1.0	1.0	1.0	2.0	0.5	0.5	0.5	0.5
RULA	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
RULE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0
RUPA	0.0	0.0	0.0	0.0	0.0	1.0	0.5	0.0	0.5	0.0	0.0	0.0	0.0	0.1	0.0
RUDI	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0
RUUR	12.0	10.0	6.0	0.0	14.0	3.0	15.0	5.0	4.0	40.0	8.0	0.0	1.0	12.0	18.0
SAGL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SYAL	3.0	3.0	4.0	1.0	10.0	8.0	8.0	0.1	0.0	3.0	3.0	0.1	0.5	0.1	2.0
SYMO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
VAPA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Appendix 5. (cont.)

	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90
POMU	3.0	45.0	4.0	20.0	15.0	10.0	1.0	6.0	40.0	5.0	10.0	1.0	0.0	2.0	8.0
PTAQ	0.1	0.0	4.0	0.1	0.0	0.0	5.0	0.5	0.0	0.1	0.0	0.0	0.5	0.0	20.0
ACTR	0.0	0.0	10.0	1.0	0.0	10.0	0.0	2.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0
ACRU	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ADBI	3.0	0.5	7.0	1.0	0.5	2.0	6.0	2.0	0.5	0.1	0.1	0.1	1.0	1.0	2.0
ANDE	0.0	0.0	0.1	0.0	0.0	4.0	0.0	0.1	1.0	0.1	0.0	0.1	0.0	0.0	0.0
ARMA	0.0	0.0	1.0	0.0	8.0	0.0	5.0	0.0	0.0	5.0	0.0	0.0	0.1	0.0	0.0
ASCA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CASC	0.0	0.0	0.1	0.0	0.1	0.5	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.1
COLA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DIFO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DIHO	0.0	0.0	3.0	0.0	0.0	0.1	0.5	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0
FRVE	0.1	0.0	0.1	0.0	0.5	0.0	3.0	0.5	0.0	0.0	0.0	0.0	0.1	0.1	0.1
GAAP	1.0	0.1	0.1	0.0	2.0	1.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GATR	2.0	3.0	1.0	2.0	2.0	2.0	0.5	6.0	0.0	2.0	3.0	0.5	0.5	0.1	2.0
GOOB	0.1	1.0	0.1	1.0	0.1	0.1	0.0	0.5	0.1	0.1	0.0	0.1	0.1	0.1	0.0
HIAL	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.1	0.1	0.0
HYOC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IRTE	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LAMU	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
LATHY	0.0	0.0	2.0	0.1	0.0	0.0	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0
LIAP	0.0	0.0	0.0	0.0	0.1	0.0	8.0	0.0	0.0	3.0	0.1	0.0	0.0	0.0	0.5
MOSI	0.5	12.0	0.0	0.0	0.0	0.1	0.0	0.0	3.0	2.0	0.0	0.0	0.0	0.0	0.0
NEPA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OSCH	8.0	8.0	0.5	2.0	15.0	3.0	1.0	6.0	2.0	3.0	2.0	4.0	2.0	2.0	2.0
PRVU	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
SACR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
SADO	3.0	1.0	0.0	2.0	7.0	0.0	0.0	0.1	0.0	0.1	0.1	0.0	0.0	0.5	8.0
SEJA	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0
SMRA	0.0	0.0	1.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SMST	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
STCR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SYRE	0.0	0.0	0.5	0.0	0.0	0.0	5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TEGR	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0
THOC	0.0	0.0	5.0	0.0	0.0	2.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0
TRLA	1.0	1.0	1.0	2.0	2.0	4.0	6.0	0.0	4.0	2.0	2.0	3.0	0.0	0.0	0.0
TROV	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0
VAHE	0.0	0.0	10.0	0.5	0.0	3.0	2.0	10.0	10.0	2.0	0.0	0.1	0.1	0.0	4.0
VECAC	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
VICIA	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
VIGL	0.0	0.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
VISE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BRSY	2.0	2.0	1.0	2.0	3.0	0.5	3.0	4.0	2.0	5.0	2.0	2.0	35.0	35.0	35.0
BRVU	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CAREX	0.5	0.0	0.1	0.0	0.0	0.1	0.0	0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.0
FEOC	1.0	0.0	0.1	0.1	0.5	2.0	1.0	0.0	0.1	0.0	0.0	0.0	0.5	0.0	0.0

Appendix 5. (cont.)

	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105
ABGRA	0.0	0.0	7.0	1.0	10.0	2.0	2.0	0.0	8.0	5.0	7.0	3.0	10.0	6.0	1.0
ABGRB	0.0	0.0	4.0	0.0	0.0	5.0	10.0	0.0	6.0	15.0	15.0	3.0	20.0	0.0	0.0
ABGRC	0.0	0.0	45.0	0.0	0.0	0.0	8.0	0.0	0.0	0.0	0.0	5.0	25.0	0.0	0.0
ACMAA	1.0	0.0	0.1	0.0	0.0	1.0	0.1	1.0	0.1	2.0	0.1	1.0	0.1	0.1	2.0
ACMAB	8.0	5.0	3.0	5.0	0.0	0.0	20.0	30.0	5.0	1.0	10.0	4.0	0.0	40.0	25.0
ACMAC	0.0	25.0	30.0	20.0	0.0	0.0	25.0	30.0	25.0	0.0	70.0	18.0	0.0	20.0	30.0
ALRUA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ALRUB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ARMEA	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0	0.0	0.1	0.0	0.0
ARMEB	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.0	0.0	0.0	0.0	0.0	0.5
CONUA	0.0	0.0	0.5	0.0	0.0	0.0	0.0	2.0	0.0	0.5	0.5	4.0	0.0	0.0	0.1
CONUB	0.0	0.0	0.0	3.0	0.0	0.0	0.0	12.0	0.0	0.0	0.0	15.0	4.0	0.0	0.0
FRLAA	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0
FRLAB	0.0	0.0	0.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FRLAC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PIPOC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PRUNUA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PRUNUB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PRUNUC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PREMA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PREMB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PREMC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PSMEA	0.0	0.0	0.0	0.0	3.0	0.0	0.0	3.0	0.0	1.0	1.0	0.5	2.0	0.0	0.5
PSMEB	0.0	3.0	0.0	10.0	2.0	0.0	1.0	1.0	6.0	5.0	0.0	0.0	1.0	1.0	0.0
PSMEC	65.0	45.0	40.0	40.0	50.0	70.0	60.0	35.0	55.0	60.0	40.0	60.0	40.0	60.0	65.0
QUGAA	1.0	0.1	2.0	0.5	0.1	0.1	0.1	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.5
QUGAB	0.0	0.0	0.0	0.0	15.0	1.0	0.5	0.0	0.0	1.0	0.0	0.0	0.5	0.0	0.0
QUGAC	0.0	3.0	0.0	20.0	25.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TABRA	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TABRB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TABRC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
THPLA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
THPLB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
THPLC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TSHEA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TSHEB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TSHEC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ACCI	0.0	0.0	3.0	0.0	0.0	0.0	0.0	2.0	0.0	0.0	6.0	0.0	70.0	0.0	0.0
AMAL	0.0	0.0	0.1	3.0	3.0	0.5	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0
BEAQ	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	40.0	2.0	0.0	0.0
BENE	0.0	0.0	0.0	0.0	1.0	0.0	0.5	15.0	0.0	0.0	0.0	0.0	8.0	0.0	0.0
COCO	10.0	1.0	15.0	0.5	1.0	8.0	10.0	3.0	7.0	18.0	12.0	15.0	9.0	15.0	6.0
GASH	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.0	0.0	0.0
HODI	0.0	0.0	0.0	0.0	1.0	0.0	4.0	0.5	0.0	0.5	0.5	7.0	9.0	0.0	0.1
LOCI	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.5	0.1	0.1	0.0	0.1	0.5	0.0	0.0
LOHI	0.1	0.1	1.0	0.1	1.0	0.0	5.0	0.0	0.0	6.0	1.0	0.0	2.0	0.1	0.1
RHPU	0.0	0.1	0.1	0.1	0.0	0.1	0.1	0.0	0.0	0.1	0.1	0.0	0.1	0.0	0.5
RHDI	10.0	8.0	15.0	20.0	25.0	12.0	4.0	0.0	0.1	30.0	25.0	0.0	5.0	3.0	3.0
RIDI	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ROSA	2.0	0.5	1.0	4.0	4.0	0.5	4.0	0.5	1.0	2.0	2.0	8.0	2.0	1.0	2.0
RULA	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.1
RULE	4.0	3.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0
RUPA	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.5	0.0	0.1	0.5	1.0	0.1	0.1	0.1
RUDI	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.0
RUUR	15.0	0.0	8.0	10.0	3.0	18.0	7.0	0.0	3.0	12.0	9.0	5.0	6.0	6.0	12.0
SAGL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SYAL	0.1	0.1	0.5	3.0	8.0	7.0	0.0	0.5	0.0	3.0	5.0	5.0	0.0	3.0	0.5
SYMO	0.0	0.0	0.0	0.0	0.0	0.0	25.0	0.0	0.0	2.0	0.0	0.0	0.0	0.1	0.0
VAPA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Appendix 5. (cont.)

	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105
POMU	30.0	4.0	3.0	4.0	0.0	6.0	5.0	14.0	14.0	4.0	5.0	20.0	3.0	10.0	13.0
PTAQ	0.0	4.0	0.0	0.0	0.0	8.0	0.0	0.0	0.5	1.0	1.0	0.0	0.0	4.0	4.0
ACTR	0.0	0.0	0.0	0.0	0.0	0.0	1.0	65.0	2.0	0.1	0.1	9.0	0.0	2.0	0.0
ACRU	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ADBI	0.0	0.1	4.0	0.0	0.1	0.0	2.0	4.0	0.1	2.0	2.0	2.0	2.0	5.0	3.0
ANDE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.1	0.0	0.1	0.5	0.0	0.0
ARMA	0.0	0.0	0.0	0.0	0.0	0.0	10.0	0.5	0.1	0.0	0.5	0.5	0.5	1.0	0.0
ASCA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CASC	0.0	0.0	0.1	0.0	0.0	0.0	2.0	3.0	0.0	0.5	0.5	0.5	1.0	0.5	0.0
COLA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DIFO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DIHO	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0	0.1	0.0	0.0	2.0	2.0	0.0	0.0
FRVE	0.0	0.0	0.1	0.1	1.0	0.0	0.5	0.0	0.1	2.0	2.0	0.0	0.0	0.0	0.0
GAAP	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GATR	0.1	0.1	0.1	0.0	0.1	0.0	1.0	0.5	0.1	1.0	2.0	1.0	2.0	0.5	2.0
GOOB	0.0	0.0	0.1	0.1	0.1	0.0	0.5	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1
HIAL	0.0	0.0	0.1	0.0	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.0	0.0	0.0	0.0
HYOC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IRTE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LAMU	0.0	0.1	0.0	0.0	0.0	0.0	0.5	0.0	0.1	0.0	0.0	0.0	0.0	1.0	0.0
LATHY	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0	0.0	0.0	0.0	0.0
LIAP	0.0	0.0	3.0	0.1	7.0	0.0	0.0	0.0	0.1	0.5	2.0	0.0	0.0	0.1	0.0
MOSI	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.0	0.1	0.0	0.0	0.0	0.0	1.0	0.0
NEPA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OSCH	0.1	2.0	2.0	2.0	3.0	0.0	4.0	3.0	1.0	2.0	8.0	4.0	4.0	2.0	2.0
PRVU	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0
SACR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SADO	0.1	0.5	0.0	3.0	8.0	0.0	5.0	0.0	0.0	3.0	2.0	0.0	2.0	0.0	0.0
SEJA	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.0
SMRA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SMST	0.0	0.0	0.0	0.0	0.0	0.5	1.0	0.0	0.0	0.0	0.1	0.0	1.0	0.0	0.0
STCR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
SYRE	0.0	0.0	0.0	0.0	1.0	0.0	3.0	0.5	0.0	0.0	0.0	0.0	2.0	0.0	0.0
TEGR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.0
THOC	0.0	0.0	0.0	0.0	0.0	0.0	0.1	7.0	0.0	0.0	0.0	4.0	0.0	0.1	0.0
TRLA	0.0	0.1	3.0	2.0	0.0	0.0	4.0	6.0	0.5	1.0	8.0	2.0	6.0	1.0	0.1
TROV	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.1	0.1	0.0	0.0
VAHE	0.0	0.0	3.0	0.0	2.0	0.0	4.0	3.0	4.0	3.0	2.0	7.0	2.0	4.0	2.0
VECAC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.5	0.0	0.0
VICIA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
VIGL	0.0	0.0	0.0	0.0	0.0	0.0	2.0	2.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0
VISE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BRSY	50.0	90.0	25.0	75.0	85.0	85.0	2.0	1.0	75.0	12.0	10.0	1.0	1.0	90.0	68.0
BRVU	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CAREX	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
FEOC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.1	0.0	0.1	0.1	0.0	0.0

Appendix 5. (cont.)

	106	107	108	109	110	111	112	113	114	115
ABGRA	1.0	0.0	1.0	0.0	0.0	1.0	0.0	3.0	0.0	2.0
ABGRB	11.0	0.0	0.0	3.0	0.0	5.0	2.0	2.0	0.0	2.0
ABGRC	4.0	0.0	1.0	0.0	0.0	0.0	5.0	6.0	0.0	4.0
ACMAA	0.1	0.0	0.1	0.0	0.1	0.0	0.0	0.0	4.0	0.1
ACMAB	2.0	5.0	0.5	0.5	15.0	0.0	8.0	3.0	2.0	8.0
ACMAC	55.0	10.0	35.0	8.0	10.0	0.0	0.0	25.0	0.0	25.0
ALRUA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ALRUB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ARMEA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
ARMEB	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0
CONUA	0.0	0.0	5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CONUB	0.0	0.0	0.0	23.0	5.0	5.0	18.0	7.0	0.0	0.0
FRLAA	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FRLAB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FRLAC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PIPOC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PRUNUA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
PRUNUB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0	2.0
PRUNUC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PREMA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PREMB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PREMC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PSMEA	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.1	0.5
PSMEB	0.0	1.0	10.0	17.0	5.0	0.0	0.0	4.0	0.0	2.0
PSMEC	55.0	40.0	20.0	38.0	60.0	15.0	70.0	55.0	75.0	41.0
QUGAA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
QUGAB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
QUGAC	4.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TABRA	0.0	0.5	0.0	0.0	0.0	0.0	0.0	2.0	0.1	0.0
TABRB	0.0	5.0	5.0	12.0	2.0	5.0	0.0	5.0	0.0	2.0
TABRC	0.0	0.0	0.0	6.0	0.0	0.0	0.0	0.0	0.0	0.0
THPLA	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0
THPLB	0.0	0.0	0.0	0.0	2.0	0.0	0.0	0.0	0.0	0.0
THPLC	0.0	0.0	0.0	0.0	2.0	10.0	0.0	0.0	0.0	0.0
TSHEA	0.0	4.0	0.1	2.0	0.0	1.0	0.0	0.0	0.0	0.0
TSHEB	0.0	15.0	0.0	1.0	5.0	6.0	0.0	0.0	0.0	0.0
TSHEC	0.0	40.0	25.0	4.0	0.0	60.0	0.0	0.0	0.0	0.0
ACCI	0.0	9.0	25.0	20.0	20.0	55.0	14.0	4.0	1.0	35.0
AMAL	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0
BEAQ	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BENE	0.0	6.0	7.0	9.0	12.0	10.0	7.0	0.0	1.0	2.0
COCO	18.0	0.0	3.0	3.0	3.0	0.0	0.0	10.0	0.0	6.0
GASH	0.0	4.0	17.0	6.0	10.0	4.0	6.0	15.0	2.0	8.0
HODI	0.0	0.1	5.0	0.0	2.0	0.0	0.0	1.0	0.0	4.0
LOCI	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LOHI	0.5	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0
RHPU	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0
RHDI	35.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
RIDI	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ROSA	0.0	1.0	1.0	0.5	3.0	2.0	1.0	3.0	0.1	1.0
RULA	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RULE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RUPA	0.0	0.1	0.5	0.0	0.1	0.1	0.0	0.1	0.0	0.1
RUDI	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RUUR	12.0	1.0	1.0	0.5	0.1	0.5	0.1	1.0	1.0	1.0
SAGL	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	4.0
SYAL	3.0	0.1	0.0	0.0	0.0	0.1	0.1	3.0	0.0	2.0
SYMO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
VAPA	0.0	0.1	1.0	0.0	2.0	0.0	0.0	0.1	0.1	0.1

Appendix 5. (cont.)

	106	107	108	109	110	111	112	113	114	115
POMU	7.0	12.0	30.0	10.0	30.0	8.0	20.0	12.0	5.0	15.0
PTAQ	3.0	0.0	0.0	0.0	0.0	0.0	0.0	4.0	1.0	0.0
ACTR	0.0	0.0	0.5	0.1	0.0	0.0	0.0	0.1	0.5	2.0
ACRU	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ADBI	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
ANDE	0.0	0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.5	0.1
ARMA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ASCA	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CASC	0.5	0.0	0.0	0.0	0.0	0.0	0.1	0.1	2.0	0.5
COLA	0.0	0.0	0.5	0.0	1.0	0.5	0.1	0.0	0.0	0.0
DIFO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DIHO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.5	0.1
FRVE	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0
GAAP	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GATR	1.0	0.1	0.1	0.0	0.1	0.0	0.5	0.1	0.1	0.5
GOOB	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
HIAL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
HYOC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IRTE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LAMU	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
LATHY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
LIAP	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MOSI	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.1	0.0
NEPA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OSCH	3.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1
PRVU	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SACR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SADO	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SEJA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SMRA	0.0	0.1	0.1	0.0	0.1	0.0	0.0	0.1	0.1	0.5
SMST	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0
STCR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SYRE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
TEGR	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.0
THOC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	1.0
TRLA	0.0	0.5	0.0	0.1	0.1	0.1	1.0	2.0	0.1	6.0
TROV	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	1.0	0.0
VAHE	2.0	0.0	0.5	0.0	1.0	0.0	0.0	0.5	1.0	2.0
VECAC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
VICIA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
VIGL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
VISE	0.0	0.5	0.1	0.0	0.1	0.1	0.1	0.1	0.0	0.1
BRSY	30.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.5
BRVU	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CAREX	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
FEOC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1

Appendix 6. Wildlife species list.*

* Compiled from species observed on McDonald-Dunn from a study titled "Comparisons of terrestrial vertebrate communities and tree regeneration among 3 silvicultural systems in the east-central Coast Range, Oregon." by McComb and Chambers (1989).

Bird species

Golden-crowned kinglet
Chestnut-backed chickadee
Hermit warbler
Winter wren
Wilson's warbler
Brown creeper
Dark-eyed junco
Swainson's thrush
American Robin
Black-headed grosbeak
Read-breasted nuthatch
Black-throated gray warbler
Orange-crowned warbler
Western flycatcher
Stellers jay
Bushtit
Evening grosbeak
Rufous hummingbird
Common flicker
Pileated woodpecker
Red-breasted sapsucker
Hairy woodpecker
Gray jay
Mountain quail
Rufous-sided towhee
Downy woodpecker
Hammond's flycatcher
Blue grouse
Red crossbill
Olive-sided flycatcher
Western tanager
Band-tailed pigeon
Pine siskin
Hermit thrush
Hutton's vireo
Townsend's warbler
Common raven
Purple finch
Pygmy owl
Western wood pewee
Willow flycatcher
White-crowned sparrow
Red-tailed hawk
American goldfinch

Appendix 6. (cont.)

Bird species

California quail
Warbling vireo
Chipping sparrow
MacGillivray's warbler
Mourning dove
Scrub jay
Violet-green swallow
Song sparrow
Sharp-shinned hawk
House wren
Turkey vulture
Ruffed grouse
Varied thrush

Mammals

Douglas squirrel
Townsend's chipmunk
Western gray squirrel
Black-tailed deer
Trowbridge's shrew
Deer mouse
Pacific shrew
Coast mole
Creeping vole
California red-backed vole
Vagrant shrew
Townsend's chipmunk
Red tree vole
Long-tailed weasel
Coyote
Brush rabbit
Garter snake
Rough-skinned newt
Elk*
Bobcat*

*observed by Leavell and Hubbard during data collection in the summer of 1989.

Appendix 7. Wildlife species on McDonald-Dunn Forest that use snag cavities.*

Species that use snags	Cavity users	Diameter **
BIRDS		
turkey vulture	NO	
northern pygmy owl	YES	17
red-breasted sapsucker	YES	15
downy woodpecker	YES	11
hairy woodpecker	YES	15
pileated woodpecker	YES	25
olive-sided flycatcher	NO	
Hammond's flycatcher	NO	
western flycatcher	NO	
chestnut-backed chickadee	YES	9
northern flicker	YES	17
red-breasted nuthatch	YES	17
brown creeper	YES	15
house wren	YES	15
winter wren	NO	
MAMMALS		
bobcat	YES	29
western grey squirrel	YES	17
deer mouse	YES	15

* from Neitro et al. (1985)
** suggested diameter suitable for nesting

Appendix 8. Complete TWINSPAN two-way table (with 68 species, and 108 plots).

Scale for cover percent values in body of table

1= >0-5%	4= 21-30%	7= 51-60%
2= 6-10%	5= 31-40%	8= 61-75%
3= 11-20%	6= 41-50%	9= 76-100%

Appendix 8. Complete TWINSPAN two-way table (with 68 species and 108 plots).

PLOT NUMBERS

```
           1       1           1 1         1                                                   1       1   11111111
       339404 899990     24 989090855678677011834455554435868 1351117124757126269 222339123675680336687702211001011
       129246391246512568539580630289060519136685815670432563719424879715007048884346067594783142752313431235780912

RIDI   -------------------------------------------1---1---------------1---1----------------------------------------  0000
RUPR   -------1----1------------------------1---11----21-----1---1--1----------------------------------------------  0000
IRTE   ---------------------------1------1-------------------------------------------------------------------------  0000
STCR   ----1-----------------------1---------1--------1-1-1------------111-----------------------------------------  0000
SACR   ----------------1---1-----------------1-----------1---1---1--1----------------------------------------------  0000
RULE   -----1--11-----------------------1-----1111111-11111------------111----1---------------11-------------------  0001
LAMU   111-1----1-----------------------3------11-1---1131121-1------111------1-------1---1-----1------------------  0001
SEJA   1------------------------111---------1---11-11---1111---------11--1----------------------11----11-----------  0001
VICIA  ---------------------------1------------1--------------------1------------------------------------1---------  0001
RULA   ------111---1---1-------1-1-------------11-------1-1-------111-----1----------------------------------------  0001
PRVU   1-----1---------------1---1---1----------------------------1------------------------------------------------  0010
BRSY   678691756989863779385955443111111111211111121111311113111111111111111111111114411111111211111111111111-------  0010
BRVU   1-------------1----1----------------1-----------------------------------------------------------------------  0010
AMAL   1-1---1---11---------11111---1----11--11---11-1------1111-----11----------1---------1--------1-----1--------  0010
LOHI   ----1111111-11--1111111-112--2---11111111-21-111-1111-1111-1--1----1-------11--111----1--------111---------1  0011
RHDI   111118132233132434451423534453164212433121121213141331212111314121111-----1-15-11131-11-1-1-----11-1-1------  0011
RHPU   -----1-1-11111--1-1---11111-11-11-111-111-1----1111111-111-111-1-1111------1---11-----1-1-1----111--1-------  0011
SADO   1----111111--1-11111-2-21-1-2211211111111121111---1-1-111-111-11-1-1-------111-11--1-------1---1-1----------  0011
RUUR   111222133-233112-11-111332333-13322-223252493425853531223212122131211111--2111122213321111112211121111111111  0011
POMU   123321114112311111111--2211142313553113222341532411142868656765899896553331211121213213153132121213333344223  010
DIFO   ------------------1------------------1-------3-------------11-1---2--1------1----1--------------1-1---------  010
MOSI   111-1-----------------------1111--1---1----1111-11111-111-11131-111-111-11---1-1-1-21-1-1-1---1---11-----1--  010
FRVE   --1----1--1----1-11-1111-1112111111-1-1-1-1-1111-1--11-111--1-11---11--1----11-1111111----1----11----------1  0110
GATR   1111111111--111111111111111123111111111111111112121121111111111111111111111111-1111111111-1111111111-11111--1  0110
OSCH   11111111111-11111-1111111111221231121111111111111111121111112111111111111111111111111111111-111-111111-----  0110
PTAQ   --121-1--1-21-1-12-1--131-111-11--11111--12121-21121-1-1121-1-----1-11111-2-11-1-1111113--112--11---1-------  0110
GOOB   11--1--1--1-11--1-11-11-111-11111-111-1--1111-1---1111-11---1111--1-1-----11--111-11-11-111---11111--1------  0110
HIAL   1------1--------1--1111--11---1--1111-1---11111-1-------11-----11-11-----1111-1-1-----1-1-1----11-111-------  0110
LIAP   --111-----1--------1-2-1-112111-111-1--1---------111-----------1-1--1---1-----11--211-----111---------------  0110
SYMO   ---11------------1--------1-----------------------------1--1-----11------------4----------------------------  0110
COCO   11233122211221113113111233332123332433561121131442243-25151311122-211111313122112212222433863421322522-111--  0110
SYAL   1--411-11112111111112211111223212121132132211111-1111112132131111-1-111111431111-1132111-1233121--11111---11  0111
ADBI   14111111-1--111-1-1111111112221111111111111111111111111111111111111111112111112222111---------  0111
ROSA   1111111111111-1111111111-111111-11111111-1111111-111111--1111-11-111111111111111111112122212111111111111111  0111
CAREX  --------------------------1---11--1-------1111------11-11-------------1----------1---11----11-11------1-1---  0111
BEAQ   ---1------------------111---1111-1--1111--11-----------11---------------1--------11-11---5-----1-1----------  0111
GAAP   -----------------------------1-11-----1---------1---11-1---111---1--1--1---------1-111----11--1-1-----------  0111
TECP   [illegible]  0111
TRLA   --1111---11-1------------112-11111121-1111111-1-111---111111-1-11--1-1121111111111111111111111111211121-1111  100
FEOC   -1-----------------1--1---1111111111----------------1------------111--1-11-11-11-----11111-1-111-1-111------  100
ARMA   111-1-----------------1----1-21-212-1-1-11--111--1-1---1-1----1---1-1--1111-111121111122-111---11111--------  101
HYOC   ---------------------------------11---1-------------1-------1-------111----------1-11-----------------------  101
LATHY  ---------------111-------111-----1111-1-----1-1---------------1---11--------1111-11111111-1------1--1-------  101
NEPA   --------------------------------------1---------------11------1---1111----1-1---11--------------------------  101
RUPA   ---11--1----1---1-1------111-----11-1--------1-31---1-11211--------1-11111--1111-1-11-111133211211--11111-1-  1100
SAGL   ------------------------------------------------1----------------------------------------------------1-----1  1100
SMRA   --------------------1---------1-----------------------------------------1--------1----------11------11111---  1100
TROV   --------------------1------------1-1-1-------1-1-----11--11-1-11---1-1111---111---1--1-11111-1111-1-----1-1-  1100
ACTR   1-1-1---------------------1-----1-11-1-----------1--21-1--1-1-11--1-1221781112111-1112111211122-1-1111-1-1--  1101
CASC   ---11---------1--------1111-1-1-111-1-1-1-1---11---------1-------11-1-1111--1111-1111-1111111111111111-----1  1101
SMST   ---1-------1------------------1--11-11--1--2-1---------------------1-4-1-1-1---111-1------1-2-11-1-------1--  1101
ANDE   11------------------------1--11---1-------1-1-1-1-1-1-----------111--1--1-11111--111111111-111-11---111--11-  1101
SYRE   --------------------11-------1---1--------1-------1--1--------------------11-11-1111-11-1-1----1-1---1------  1101
VAHE   11121--------1-------1111111111---1111-------1----21132---------2--1---31111121111-2132442241331111111-11---  1101
VIGL   ----------------------------1--------11------------1-----1-1-1---1-34--11-11111121-1112-11112--1-1----------  1101
ACRU   -------------111---------------------------------------1----------1111113-13-----1---11---1-----------------  1110
DIHO   --1------------------------111---1---------------------1-----------1-1121111111111-1-11221111311111111------  1110
THOC   ----1-------------------------------------------------------------1-112112--1111111111231111121-1---11------  1110
VECAC  -------------------------------------------------------------------------1-11--------1-1--1-1-11-11--1------  1110
BENE   -------------------1-1-------1--------------------1--1-----1---1--1-1--913-31-111----1------5-721211-1223222  1111
ASCA   ----------------------------------------------------------------------1---------------------------1---1-----  1111
ACCI   -------------------------1---------2-------------------------------------1--11-------------5184848--15243373  1111
GASH   -------------------------------------------------------------------------------------------22--4213532132212  1111
VAPA   ------------------------------------------------------------------------------------------------1---11111---  1111
COLA   -------------------------------------------------------------------------------------------------------11-11  1111
VISE   -------------------------------------------------------------------------------------------1----1-1-11111-11  1111

       000000000000000000000000000000000000000000000000000000000000000000000000001111111111111111111111111111111111
       000000000000000000000000000000111111111111111111111111111111111111111111110000000000000000000000000001111111
       000001111111111111111111111111000000000000000000000000000000111111111111110000000000000000011111111100111111
       000110000000000000000000011111000000000000000011111111111111000000000111110000001111111111100000000011 000001

            ABGR/BRSY          ABGR/RUUR-RHDI        ABGR/POMU        ABGR/DIHO-THOC        ABGR/     TSHE/
                                                                                            ACCI-     ACCI-
                                                                                            GASH      GASH
```

SPECIES ACRONYMS

SPECIES CLASSIFICATION

PLOT CLASSIFICATION

Appendix 9. Location of Tracts in McDonald-Dunn Forest.