**Example of an Ecological Data Set**

**Oak Woodlands in the Willamette Valley, Oregon, USA**

Note: This document was originally prepared by BMcCune to accompany PC-ORD.

It has been extensively updated for R by JDBakker.

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In 1961 and 1962 John F. Thilenius sampled vascular plants in oak forests in the Willamette Valley for his Ph.D. at Oregon State University (Thilenius 1963, 1968). The data came from a fairly narrow range of habitats – all of the stands were closed forests dominated by *Quercus garryana*. This resulted in a data set with fairly low beta diversity. The environmental differences among the sites are rather modest. Much of the variation in species composition presumably is derived from the particular histories of each stand, such as episodes of grazing, logging, and fire. Of course we have limited information on those histories, so you will see that much of the variation in the plant communities is not readily explained by the measured environmental and historical variables. Nevertheless a definite environmental gradient emerges from the analysis.

The abstract from Thilenius (1968) is reproduced below:

“*Quercus garryana* forests, prominent at low elevations throughout the Willamette Valley, Oregon, have developed from oak savanna subsequent to settlement of the valley in the mid-nineteenth century. Interruption of the ground fires that were common in the pre-settlement environment probably caused the change. The understory of the oak forest is dominated by shrubs, and well-defined strata are present. Four plant communities occur: (1) *Quercus garryana/Corylus cornuta* var. *californica/Polystichum munitum* (most mesic); (2) *Quercus garryana/Prunus avium/Symphoricarpos albus*; (3) *Quercus* *garryana/Amelanchier alnifolia*; (4) *Quercus garryana/Rhus diversiloba* (most xeric). All are in seral condition because of their relatively recent development and because they have been disturbed throughout their existence by man’s activities. The soils supporting the oak forest are generally deep and well drained and have developed profiles with illuvial horizons and acidic reaction. They are derived from sedimentary and basic igneous rocks and old valley-filling alluvium. Seven established soil series are present: Steiwer, Carlton, Peavine, Nekia, Dixonville, Olympic, and Amity. The Steiwer series and its catenary associate, Carlton, are the most common soils.”

Thilenius’ goals were to describe “the floristic composition, stand structure, physical environment, and successional status of plant communities where *Quercus garryana* is the major component of the overstory.” Although quantitative data were carefully recorded, Thilenius had few possibilities for multivariate analysis. His primary analyses were first arranging his data “according to similarities in species composition, importance ranks, and environmental attributes.” He then tabulated averages for species and environmental variables within the four groups.

**Files Provided**

**Oak\_Metadata.docx** – Microsoft Word file containing this document.

**Oak\_data\_47x216.csv** – a data file (47 rows x 216 columns) containing all information for 47 stands. Included in this are 27 stand-level attributes and the abundances of 189 species in each stand.

The **stand-level attributes** are described in detail below. They include environmental variables, indicators of stand history, and some community summary variables, including species richness, groups derived from cluster analysis, and community types as originally designated by Thilenius.

The **abundance values** are basal areas (ft2/acre) for trees and percentage cover for lower strata, based on 60, 0.2 m2 quadrats/stand. “Trace” was converted to 0.5%. A check on the field data sheet was converted to 0.2%. Be careful! Any use of these raw data must recognize that the columns representing the tree stratum differ in units from the lower strata. Some species are listed twice because abundance was evaluated separately for different height classes, as indicated by the suffixes (.t = tree, .s = shrub).

More on the methods from Thilenius (1968):

“Investigations were confined to closed-canopy stands 4 ha or more in area where *Quercus garryana* was the major component of the overstory. Basal area, frequency, and density of overstory trees were determined on twenty 0.004-ha circular plots spaced at 9-m intervals in four rows parallel to the slope contour. Density was recorded in four classes: saplings (< 10 cm dbh); poles (11-40 cm dbh); mature (41-100 cm dbh) and relict (> 100 cm dbh). The maximum height of trees on each plot was measured with an optical rangefinder.”

“Frequency and percentage crown coverage of shrub and herbaceous species were recorded on sixty 0.2 m2 quadrats spaced at 3-m intervals in four rows coincident with the rows of 0.004-ha plots. Very low crown coverage was recorded as trace and arbitrarily assigned a value of 0.5% for calculation purposes. Above trace, the intervals were 1% and 5%. Coverage greater than 5% was estimated to the nearest 10%.”

**Oak\_species\_189x5.csv** – a data file (189 rows x 5 columns) containing information about each of the 189 species codes. In particular, the ‘LifeForm’ column indicates whether each taxa was assigned to the Herb, Graminoid, Shrub, or Tree life form. Some woody taxa were present in two height classes and are therefore recorded as two species codes as indicated by the suffixes (.t = tree, .s = shrub).

**List of Species Codes**

Lower-case species codes refer to unique species. Codes that are in all caps (e.g., ALL, GAL) refer to genera.

Note: because woody species may occur in more than one stratum, a suffix (.s, .t) is used to indicate a given species in the shrub or tree stratum.

Abgr.s Abies grandis SHRUB

Abgr.t Abies grandis

Acar Actea arguta

Acgld.t Acer glabrum var. douglasii

Acma.s Acer macrophyllum shrub

Acma.t Acer macrophyllum

Acmi Achillea millefolium

Adbi Adenocaulon bicolor

Agha Agrostis hallii

Agre Agropyron repens

Agse Agrostis semiverticullata (subsecundum)

Agte Agrostis tenuis

Aica Aira caryophyllea

ALL Allium sp.

Alpr Alopecurus pratensis

Amal.s Amelanchier alnifolia shrub

Amal.t Amelanchier alnifolia

Apan Apocynum androsaemifolium

Aqfo Aquilegia formosa

Arel Arrhenatherum elatius

Arme.s Arbutus menziesii SHRUB

Arme.t Arbutus menziesii

Avfa Avena fatua

Beaq.s Berberis aquifolium

Brco Bromus commutatus

Brla Bromus laevipes

Brpu Brodiaea pulchella

Brri Bromus rigidus

Brse Bromus secalinus

Brst Bromus sterilis

Brvu Bromus vulgeris

Caqu Camassia quamash

CAR Carex sp.

Cato Calochortus tolmiei

Cear Cerastium arenses

Ceum Centaurium umbellatum

Ceve.s Ceanothus velutinus

Cipa Circaea pacifica

Civu Cirsium vulgare

Coco.s Corylus cornuta shrub

Coco.t Corylus cornuta

Cogr Collomia grandiflora

Conu.s Cornus nuttallii SHRUB

Conu.t Cornus nuttallii

CORY.t Corylus sp.

Cost Corallorhiza striata

Crca Crepis capillaris

Crdo.s Crataegus douglasii

Crdo.t Crataegus douglasii

Crox.s Crataegus oxyacantha

Cyec Cynosurus echinatus

Cyfo Cystopteris fragilis

Cygr Cynoglossum grande

Daca Danthonia californica

Dacar Daucus carota

Dagl Dactylis glomerata

Deel Deschampsia elongata

Diar Dianthus armeria

Doel Downingia elegans

Drar Dryopteris arguta

Elgl Elymus glaucus

Erla Eriophyllum lanatum

Erog Erythronium oregonum

Eucr Euphorbia crenulata

Feca Festuca californica

Fede Festuca dertonenses

Feel Festuca elatior var. arendmaceae

Feme Festuca megalura

Feoc Festuca occidentalis

Feru Festuca rubra

Frbr Fragaria bracteata (vesca)

Frcu Fragaria cuneifolia

Frla.s Fraxinus latifolia shrub

Frla.t Fraxinus latifolia

Frvi Fragaria virginiana

GAL Galium sp.

Gema Geum macrophyllum

Geog Geranium oreganum (incisum)

Gepu Geranium pusillum

Haob Habenaria orbiculata

Haun Habenaria unalacensis

Hehe.s Hedera helix

Heke Hemizonia kelloggii? [misspelled Hedera helix?]

Hemi Heuchera micrantha

Hodi.s Holodiscus discolor

Hola Holcus lanatus

Hyoc Hydrophyllum occidentale

Hype Hypericum perforatum

Hyra Hypochaeris radicata

Irte Iris tenax

JUNC Juncus sp.

Kocr Koeleria cristata

Laco Lapsana communis

Lapo Lathyrus polyphyllus

Lasa Lathyrus sativus (Pisum sativum)

Liap Ligusticum apiifolium

Libu Lithophragma bulbifera

Lico Lilium columbianum

Lide.s Calocedrus (Libocedrus) decurrens

Lide.t Calocedrus (Libocedrus) decurrens

LILI Lilium sp.

Loci.s Lonicera ciliosa

Lope Lolium perenne

LOT Lotus sp.

Lotr Lomatium triternatum

Lumu Luzula multiflora

Maex Madia exigua

MAL.s Malvaceae sp. [Malus sp.?]

MAL.t Malvaceae sp. [Malus sp.?]

Maor Marah oreganus

Mebu Melica bulbosa

Mila Microseris laciniata

Mope Montia perfoliata

Mosi Montia sibirica

Nepa Nemophylla parviflora

ONGR Onagraceae sp.

Osce.s Oemleria (Osmaronia) cerasiformis

Osce.t Oemleria (Osmaronia) cerasiformis tree

Osnu Osmorhiza nuda (chilensis)

Phca.s Physocarpus capitatus

Phle.s Philadelphus lewisii

Phpr Phleum pratense

Phvi.s Phoradendron villosum

Pipo.s Pinus ponderosa

Pipo.t Pinus ponderosa

Plla Plantago lanceolata

Poco Poa compressa

Pogl Potentilla glandulosa

Pogr Potentilla gracilis

Pomu Polystichum munitum

Popr Poa pratensis

Povu Polypodium vulgare

Prav.s Prunus avium shrub

Prav.t Prunus avium

Prde.s Prunus virginiana var. demissa shrub

Prde.t Prunus virginiana var. demissa

Prvu Prunella vulgeris

Psme.s Pseudotsuga menziesii shrub

Psme.t Pseudotsuga menziesii

Ptan Pterospora andromedia

Ptaq Pteridium aquilinum var. lanuginosum

Pyco.s Pyrus communis shrub

Pyco.t Pyrus communis

Pyfu.s Pyrus fusca SHRUB

Pyfu.t Pyrus fusca

Quga.s Quercus garryana shrub

Quga.t Quercus garryana

Raoc Ranunculus occidentalis

Rhdi.s Rhus diversiloba

Rhpu.s Rhamnus purshiana shrub

Rhpu.t Rhamnus purshiana

Risa.s Ribes sanguinius

Rodu.s Rosa??? [Rosa durandii?]

Roeg.s Rosa eglanteria

Rogy.s Rosa gymnocarpa

Romi.s Rosa micrantha?

Ronu.s Rosa nutkana

Ropi.s Rosa pisocarpa

Ruac Rumex acetosella

Rula.s Rubus laciniatus

Rule.s Rubus leucodermus

Rupa.s Rubus parvifloris

Rupr.s Rubus procerus

Ruur.s Rubus ursinus

Sacr Sanicula crassicaulis

Sado Satureja douglasii

Sagr Sanicula graveolens

Seja Senecio jacobaea

Siho Silene hookeri

Smra Smilacina racemosa

Smse Smilacina sessilifolia

Syal.s Symphoricarpus albus

Taas Taeniatherum asperum

Taof Taraxacum officinale

Tegr Tellima grandiflora

Thoc Thalictrum occidentale

Toar Torilis arvensis

Trca Trisetum canescens

TRIF Trifolium sp

Trla Trientalis latifolia

Trov Trillium ovatum

Trpr Trifolium procumbens

V.1 Vicia sp.

Valo Valerianella locusta

Viam Vicia americana

Viel.s Viburnum ellipticum

Vinu Viola nuttallii

VIOL Viola sp

Zice Zygadenus venosus

**Coding for Stand-Level Attributes**

**Topographic and geographic variables**

Elev.m = elevation above sea level in meters.

LatAppx = approximate latitude, decimal degrees, based on automated conversion of Township/Range/Section, using the program TRS2LL.exe.

LongAppx = approximate longitude, decimal degrees, based on automated conversion of Township/Range/Section, using the program TRS2LL.exe.

Slope.deg = slope in degrees (originally recorded in percentages)

AspClass = aspect class; None, SW, S.or.W, SE.or.NW, N.or.E, NE

Asp.deg = aspect in degrees E of N

PDIR = Potential annual direct incident radiation, MJ/cm2/yr, calculated according to McCune and Keon (2002) Eq. 3.

HeatLoad = Heat load index, calculated according to McCune and Keon (2002).

Landform = verbal description of landform; Valley.bottom, Draw, Slope, Ridge

TopoClass = verbal description of topographic position class; Bottomland, Ravine, Sheltered.slope.N.or.E, Sheltered.slope.W.or.S, Open.slope.N.or.E, Open.slope.W.or.S, Ridges.NE, Ridges.NW.or.SE

**Soil variables**

DrainageClass = verbal description of drainage; Poor, Moderate, Good, Well

SoilSeriesName = verbal description of soil series; Steiwer, Peavine, Dixonville, Nekia, Carlton, Olympia, Amity

SoilGroupName; Sedimentary, Basic.igneous, Alluvial

AHoriz = thickness of A horizon, cm

B1Horiz = thickness of B1 horizon, cm

B2Horiz = thickness of B2 horizon, cm

B3Horiz = thickness of B3 horizon, cm (if profile truncated, e.g. “44+ inches”, add 20 inches)

BHoriz = sum of B1+B2+B3, cm

**Indicators of stand history**

GrazCurr = verbal class of current grazing status as recorded on field data sheet; Yes, No

GrazPast = verbal class of past grazing status as recorded on field data sheet (must be ‘Yes’ if GrazCurr = Yes); Yes, No

NotLogged = verbal class of evidence of past logging, based on guess that ‘NPL’ recorded under ‘Influences’ on datasheet means ‘no past logging’; Yes, No

Quga.gt60cm = number of *Quercus garryana* recorded in the 60 cm (24 inch) size class and larger. (No stands had large *Pseudotsuga*; one stand (Stand05) had a large *Acer macrophyllum* and one stand (Stand07) had two large *Arbutus menziesii*)

LogQuga.gt60cm = log of (*x*+1) where *x* is the number of *Quercus garryana* recorded in the 60 cm (24 inch) size class and larger (i.e. x = “Quqa.gt60cm”).

TreeHt.m = maximum height of *Quercus garryana*, in meters.

**Community summary variables derived from the species matrix**

SppRich = species richness, counting each species x layer combination as a separate species.

ThilTypeCode = vegetation types from Thilenius (1968)

Quga.Coco.Pomu = *Quercus/Corylus/Polystichum*

Quga.PRU.Syal = *Quercus/Prunus/Symphoricarpos*

Quga.Amal.Syal = *Quercus/Amelanchier/Symphoricarpos*

Quga.Rhdi = *Quercus/Rhus*

FlxB.0.25 = community types defined at the 4-group level from hierarchical cluster analysis, Flexible beta method, Sørensen distance, beta= -0.25.

**Acknowledgments**

Bruce McCune obtained the original raw data cards from Thilenius' study in 1963 (data collected in 1961 and 1962) from John Thilenius via Bob Frenkel. Thanks to John Thilenius for granting permission to distribute his data. Bill Daly did the initial data entry. Bibit Traut added more variables and resolved numerous nomenclatural questions regarding the species codes used by Thilenius.

**References**

McCune, B. and D. Keon. 2002. Equations for potential annual direct incident radiation and heat load. *Journal of Vegetation Science* 13:603-606.

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