Week 2 Exercise

Z620: Quantitative Biodiversity, Indiana University

November 8, 2014

In this exercise, we will conduct exercises on alpha diversity

RETRIEVE AND SET YOUR WORKING DIRECTORY

```
getwd()
```

```
## [1] "/Users/lennonj/GitHub/Quantitative_Biodiversity/Assignments/Week2"
```

```
setwd("/Users/lennonj/GitHub/Quantitative_Biodiversity/Assignments/Week2")
```

INSTALL PACKAGES

People develop different packages for certain tasks that can be carried out in the R enviornment. Use the 'help'funciton to learn about package installation and add-ons. install.packages("vegan")

```
require("vegan")
```

```
## Loading required package: vegan
## Loading required package: permute
## Loading required package: lattice
## This is vegan 2.0-10
```

```
library("vegan")
```

In the library of vegan, there is a data set that we will be using called BCI. BCI stands for Barro Colorado Island, which is a located in Panama. The BCI data frame has 50 plots (rows) of 1 hectare with counts of trees on each plot with total of 225 species (columns)

```
data(BCI)
```

Let's look at the data in the first few plots

```
head(BCI)
```

```
##   Abarema.macradenium Acacia.melanoceras Acalypha.diversifolia
## 1                   0                  0                     0
## 2                   0                  0                     0
## 3                   0                  0                     0
## 4                   0                  0                     0
## 5                   0                  0                     0
## 6                   0                  0                     0
##   Acalypha.macrostachya Adelia.triloba Aegiphila.panamensis
```

```
## 1                     0             0                   0
## 2                     0             0                   0
## 3                     0             0                   0
## 4                     0             3                   0
## 5                     0             1                   1
## 6                     0             0                   0
##   Alchornea.costaricensis Alchornea.latifolia Alibertia.edulis
## 1                       2                   0               0
## 2                       1                   0               0
## 3                       2                   0               0
## 4                      18                   0               0
## 5                       3                   0               0
## 6                       2                   1               0
##   Allophylus.psilospermus Alseis.blackiana Amaioua.corymbosa
## 1                       0              25                 0
## 2                       0              26                 0
## 3                       0              18                 0
## 4                       0              23                 0
## 5                       1              16                 0
## 6                       0              14                 0
##   Anacardium.excelsum Andira.inermis Annona.spraguei Apeiba.aspera
## 1                   0             0               1            13
## 2                   0             0               0            12
## 3                   0             0               1             6
## 4                   0             0               0             3
## 5                   0             1               0             4
## 6                   0             1               0            10
##   Apeiba.tibourbou Aspidosperma.cruenta Astrocaryum.standleyanum
## 1                2                    0                       0
## 2                0                    0                       2
## 3                1                    0                       1
## 4                1                    1                       5
## 5                0                    1                       6
## 6                0                    1                       2
##   Astronium.graveolens Attalea.butyracea Banara.guianensis
## 1                    6                 0                0
## 2                    0                 1                0
## 3                    1                 0                0
## 4                    3                 0                0
## 5                    0                 0                0
## 6                    1                 1                0
##   Beilschmiedia.pendula Brosimum.alicastrum Brosimum.guianense
## 1                     4                   5                 0
## 2                     5                   2                 0
## 3                     7                   4                 0
## 4                     5                   3                 0
## 5                     8                   2                 0
## 6                     6                   2                 0
##   Calophyllum.longifolium Casearia.aculeata Casearia.arborea
## 1                       0                 0               1
## 2                       2                 0               1
## 3                       0                 0               3
## 4                       2                 0               2
## 5                       1                 0               4
```

```
## 6                       2                 0                 1
##   Casearia.commersoniana Casearia.guianensis Casearia.sylvestris
## 1                      0                   0                   2
## 2                      0                   0                   1
## 3                      1                   0                   0
## 4                      0                   0                   0
## 5                      1                   0                   0
## 6                      0                   0                   3
##   Cassipourea.elliptica Cavanillesia.platanifolia Cecropia.insignis
## 1                     2                         0                12
## 2                     0                         0                 5
## 3                     1                         0                 7
## 4                     1                         0                17
## 5                     3                         0                21
## 6                     4                         0                 4
##   Cecropia.obtusifolia Cedrela.odorata Ceiba.pentandra Celtis.schippii
## 1                    0               0               0               0
## 2                    0               0               1               0
## 3                    0               0               1               0
## 4                    0               0               0               2
## 5                    1               0               1               2
## 6                    0               0               0               0
##   Cespedezia.macrophylla Chamguava.schippii Chimarrhis.parviflora
## 1                      0                  0                     0
## 2                      0                  0                     0
## 3                      0                  0                     0
## 4                      0                  0                     0
## 5                      0                  0                     0
## 6                      0                  0                     0
##   Chlorophora.tinctoria Chrysochlamys.eclipes Chrysophyllum.argenteum
## 1                     0                     0                      4
## 2                     0                     0                      1
## 3                     0                     0                      2
## 4                     0                     0                      2
## 5                     0                     0                      6
## 6                     0                     0                      2
##   Chrysophyllum.cainito Coccoloba.coronata Coccoloba.manzanillensis
## 1                     0                  0                       0
## 2                     0                  0                       0
## 3                     0                  0                       0
## 4                     0                  1                       0
## 5                     0                  2                       0
## 6                     0                  0                       0
##   Colubrina.glandulosa Cordia.alliodora Cordia.bicolor Cordia.lasiocalyx
## 1                    0                2             12                8
## 2                    0                3             14                6
## 3                    0                3             35                6
## 4                    0                7             23               11
## 5                    0                1             13                7
## 6                    0                1              7                6
##   Coussarea.curvigemmia Croton.billbergianus Cupania.cinerea
## 1                     0                    2               0
## 2                     0                    2               0
## 3                     0                    0               0
```

```
## 4                    1                  11              0
## 5                    0                   6              0
## 6                    2                   0              0
##   Cupania.latifolia Cupania.rufescens Cupania.sylvatica
## 1                 0                 0                2
## 2                 0                 0                2
## 3                 0                 0                1
## 4                 1                 0                0
## 5                 0                 0                3
## 6                 0                 0                0
##   Dendropanax.arboreus Desmopsis.panamensis Diospyros.artanthifolia
## 1                    0                    0                       1
## 2                    3                    0                       1
## 3                    6                    4                       1
## 4                    0                    0                       1
## 5                    5                    0                       0
## 6                    2                    0                       0
##   Dipteryx.panamensis Drypetes.standleyi Elaeis.oleifera
## 1                   1                 2              0
## 2                   1                 1              0
## 3                   3                 2              0
## 4                   0                 0              0
## 5                   0                 0              0
## 6                   0                 0              0
##   Enterolobium.schomburgkii Erythrina.costaricensis
## 1                         0                       0
## 2                         0                       0
## 3                         0                       0
## 4                         0                       0
## 5                         0                       0
## 6                         0                       3
##   Erythroxylum.macrophyllum Eugenia.coloradensis Eugenia.galalonensis
## 1                         0                    0                    0
## 2                         1                    1                    0
## 3                         0                    0                    0
## 4                         0                    7                    0
## 5                         0                    2                    0
## 6                         0                    0                    0
##   Eugenia.nesiotica Eugenia.oerstedeana Faramea.occidentalis
## 1                 0                   3                  14
## 2                 0                   2                  36
## 3                 1                   5                  39
## 4                 0                   1                  39
## 5                 0                   5                  22
## 6                 0                   2                  16
##   Ficus.colubrinae Ficus.costaricana Ficus.insipida Ficus.maxima
## 1                0                 0              0           1
## 2                1                 0              0           0
## 3                0                 0              0           0
## 4                0                 0              0           0
## 5                0                 0              0           0
## 6                0                 0              0           0
##   Ficus.obtusifolia Ficus.popenoei Ficus.tonduzii Ficus.trigonata
## 1                 0              0              0               0
```

```
## 2                 0              0              0              0
## 3                 0              0              1              0
## 4                 0              0              2              0
## 5                 0              0              1              0
## 6                 0              0              0              0
##   Ficus.yoponensis Garcinia.intermedia Garcinia.madruno Genipa.americana
## 1                1                   0                4                0
## 2                0                   1                0                0
## 3                0                   1                0                1
## 4                0                   3                0                0
## 5                0                   2                1                0
## 6                1                   1                0                0
##   Guapira.standleyana Guarea.fuzzy Guarea.grandifolia Guarea.guidonia
## 1                   3            1                  0               2
## 2                   1            1                  0               6
## 3                   0            0                  0               2
## 4                   1            1                  0               5
## 5                   1            3                  0               3
## 6                   7            0                  0               4
##   Guatteria.dumetorum Guazuma.ulmifolia Guettarda.foliacea
## 1                   6                 0                 1
## 2                  16                 0                 5
## 3                   6                 0                 1
## 4                   3                 1                 2
## 5                   9                 0                 1
## 6                   7                 0                 0
##   Gustavia.superba Hampea.appendiculata Hasseltia.floribunda
## 1               10                    0                   5
## 2                5                    0                   9
## 3                0                    1                   4
## 4                1                    0                  11
## 5                3                    0                   9
## 6                1                    0                   2
##   Heisteria.acuminata Heisteria.concinna Hirtella.americana
## 1                   0                  4                 0
## 2                   0                  5                 0
## 3                   0                  4                 0
## 4                   0                  6                 0
## 5                   1                  4                 0
## 6                   1                  8                 0
##   Hirtella.triandra Hura.crepitans Hyeronima.alchorneoides Inga.acuminata
## 1                21              0                       0              0
## 2                14              0                       2              0
## 3                 5              0                       0              0
## 4                 4              0                       0              0
## 5                 6              0                       0              0
## 6                 6              2                       0              0
##   Inga.cocleensis Inga.goldmanii Inga.laurina Inga.marginata Inga.nobilis
## 1               2              0            0              0            0
## 2               4              0            0              0            0
## 3               4              1            0              2            1
## 4               6              0            0              4            3
## 5               0              2            1              0            1
## 6               0              1            0              0            0
```

```
##   Inga.oerstediana Inga.pezizifera Inga.punctata Inga.ruiziana
## 1                0                0             3             0
## 2                0                0             0             0
## 3                0                0             0             0
## 4                0                0             0             0
## 5                0                0             0             0
## 6                0                0             0             0
##   Inga.sapindoides Inga.spectabilis Inga.umbellifera Jacaranda.copaia
## 1                2                0                0               6
## 2                0                2                0              10
## 3                3                0                0               9
## 4                2                1                1               2
## 5                5                0                0               3
## 6                0                0                0               7
##   Lacistema.aggregatum Lacmellea.panamensis Laetia.procera Laetia.thamnia
## 1                    1                    1              0              0
## 2                    0                    0              1              1
## 3                    0                    0              1              1
## 4                    1                    2              0              0
## 5                    1                    2              1              0
## 6                    2                    1              0              0
##   Lafoensia.punicifolia Licania.hypoleuca Licania.platypus
## 1                     0                 0                0
## 2                     0                 0                0
## 3                     0                 0                0
## 4                     0                 0                0
## 5                     0                 1                0
## 6                     0                 0                0
##   Lindackeria.laurina Lonchocarpus.latifolius Luehea.seemannii
## 1                   0                       7               1
## 2                   0                       7               0
## 3                   0                       3               0
## 4                   0                       9               0
## 5                   0                       2               1
## 6                   0                       1               1
##   Macrocnemum.roseum Maquira.costaricana Margaritaria.nobilis
## 1                  0                   4                    0
## 2                  0                   3                    0
## 3                  0                   7                    0
## 4                  0                   7                    0
## 5                  0                  10                    1
## 6                  0                   4                    0
##   Marila.laxiflora Maytenus.schippii Miconia.affinis Miconia.argentea
## 1                1                 2               0               2
## 2                0                 0               0               0
## 3                0                 0               0               1
## 4                0                 1               1               0
## 5                0                 0               0               1
## 6                0                 1               0               0
##   Miconia.elata Miconia.hondurensis Mosannona.garwoodii Myrcia.gatunensis
## 1             0                   0                   1                1
## 2             0                   0                   0                0
## 3             0                   0                   0                0
## 4             0                   0                   0                0
```

```
## 5             0                   0                   1                 0
## 6             0                   0                   1                 0
##   Myrospermum.frutescens Nectandra.cissiflora Nectandra.lineata
## 1                      0                   0                 0
## 2                      0                   1                 0
## 3                      0                   2                 0
## 4                      0                   2                 0
## 5                      0                   2                 0
## 6                      2                   0                 0
##   Nectandra.purpurea Ochroma.pyramidale Ocotea.cernua Ocotea.oblonga
## 1                  1                  1             0              0
## 2                  0                  0             0              0
## 3                  0                  0             1              1
## 4                  0                  0             1              2
## 5                  0                  0             0              0
## 6                  1                  0             0              0
##   Ocotea.puberula Ocotea.whitei Oenocarpus.mapora Ormosia.amazonica
## 1               0             1                22                 0
## 2               0             0                21                 0
## 3               0             2                14                 0
## 4               2             3                23                 0
## 5               0            16                17                 0
## 6               1             3                19                 0
##   Ormosia.coccinea Ormosia.macrocalyx Pachira.quinata Pachira.sessilis
## 1                0                  0               0                0
## 2                0                  0               0                0
## 3                0                  0               0                0
## 4                0                  0               0                0
## 5                0                  0               0                0
## 6                0                  0               0                0
##   Perebea.xanthochyma Phoebe.cinnamomifolia Picramnia.latifolia
## 1                   0                     0                  0
## 2                   1                     0                  0
## 3                   0                     1                  1
## 4                   0                     0                  0
## 5                   1                     1                  0
## 6                   0                     0                  0
##   Piper.reticulatum Platymiscium.pinnatum Platypodium.elegans
## 1                 0                     3                   2
## 2                 0                     3                   1
## 3                 0                     5                   3
## 4                 0                     1                   0
## 5                 2                     1                   0
## 6                 0                     1                   2
##   Posoqueria.latifolia Poulsenia.armata Pourouma.bicolor
## 1                    0              24                5
## 2                    1              16                3
## 3                    0              28                0
## 4                    0              15                0
## 5                    0              25                1
## 6                    0              15                0
##   Pouteria.fossicola Pouteria.reticulata Pouteria.stipitata
## 1                  0                   5                 0
## 2                  0                   7                 0
```

```
## 3                  0                  3                  1
## 4                  0                  6                  0
## 5                  0                  5                  0
## 6                  0                  4                  0
##   Prioria.copaifera Protium.costaricense Protium.panamense
## 1                13                   5                 2
## 2                12                   4                 0
## 3                12                   1                 2
## 4                 5                   3                 3
## 5                 3                   7                 2
## 6                26                   1                 1
##   Protium.tenuifolium Pseudobombax.septenatum Psidium.friedrichsthalianum
## 1                  11                       0                           0
## 2                   8                       0                           0
## 3                   3                       0                           0
## 4                   9                       0                           0
## 5                   3                       0                           0
## 6                   2                       0                           0
##   Psychotria.grandis Pterocarpus.rohrii Quararibea.asterolepis
## 1                  0                 1                     11
## 2                  0                 0                     12
## 3                  0                 0                     15
## 4                  0                 2                     14
## 5                  0                 1                      9
## 6                  0                 1                      3
##   Quassia.amara Randia.armata Sapium.broadleaf Sapium.glandulosum
## 1             0             3                0                 0
## 2             0             2                0                 0
## 3             0             1                0                 1
## 4             0             4                0                 0
## 5             0             2                0                 2
## 6             0             9                0                 0
##   Schizolobium.parahyba Senna.dariensis Simarouba.amara
## 1                     0               0              14
## 2                     0               0               6
## 3                     0               0              16
## 4                     0               0               8
## 5                     0               0               7
## 6                     1               0               7
##   Siparuna.guianensis Siparuna.pauciflora Sloanea.terniflora
## 1                   3                    0                 1
## 2                   2                    0                 0
## 3                   1                    1                 2
## 4                   2                    0                 2
## 5                   0                    3                 3
## 6                   1                    0                 2
##   Socratea.exorrhiza Solanum.hayesii Sorocea.affinis Spachea.membranacea
## 1                 15               0               1                  0
## 2                 22               0               1                  0
## 3                 31               0               1                  0
## 4                  9               0               1                  0
## 5                 55               1               0                  0
## 6                 44               0               1                  0
##   Spondias.mombin Spondias.radlkoferi Sterculia.apetala
```

```
## 1               1                   2                1
## 2               1                   0                2
## 3               0                   3                0
## 4               1                   3                0
## 5               1                   5                0
## 6               0                   0                1
##   Swartzia.simplex.var.grandiflora Swartzia.simplex.var.ochnacea
## 1                                3                             1
## 2                                3                             4
## 3                                0                             2
## 4                                1                             2
## 5                                1                             1
## 6                                9                             5
##   Symphonia.globulifera Tabebuia.guayacan Tabebuia.rosea
## 1                     0                 1              1
## 2                     1                 0              2
## 3                     1                 1              1
## 4                     1                 0              2
## 5                     2                 0              3
## 6                     0                 1              0
##   Tabernaemontana.arborea Tachigali.versicolor Talisia.nervosa
## 1                       9                    6              0
## 2                       5                    1              0
## 3                       6                    3              0
## 4                      10                    3              0
## 5                      16                    0              0
## 6                      11                    1              0
##   Talisia.princeps Terminalia.amazonia Terminalia.oblonga
## 1                1                   1                  0
## 2                0                   0                  0
## 3                0                   0                  0
## 4                0                   0                  0
## 5                0                   1                  0
## 6                0                   1                  0
##   Tetragastris.panamensis Tetrathylacium.johansenii Theobroma.cacao
## 1                       5                         0              1
## 2                       7                         0              1
## 3                      10                         0              0
## 4                      10                         0              0
## 5                       7                         0              1
## 6                      17                         0              0
##   Thevetia.ahouai Tocoyena.pittieri Trattinnickia.aspera Trema.micrantha
## 1               0                 0                    3              0
## 2               0                 1                    1              0
## 3               0                 0                    1              0
## 4               0                 0                    0              2
## 5               0                 0                    2              1
## 6               0                 0                    0              0
##   Trichanthera.gigantea Trichilia.pallida Trichilia.tuberculata
## 1                     0                 0                    18
## 2                     0                 1                    27
## 3                     0                 0                    28
## 4                     0                 1                    35
## 5                     0                 0                    15
```

```
## 6                     0                 0                    31
##   Trichospermum.galeottii Triplaris.cumingiana Trophis.caucana
## 1                       0                    0               2
## 2                       0                    0               0
## 3                       0                    0               0
## 4                       0                    0               0
## 5                       0                    0               2
## 6                       0                    1               0
##   Trophis.racemosa Turpinia.occidentalis Unonopsis.pittieri
## 1                1                     0                  1
## 2                1                     1                  5
## 3                0                     1                 12
## 4                1                     4                  3
## 5                0                     2                  4
## 6                0                     1                  3
##   Virola.multiflora Virola.sebifera Virola.surinamensis Vismia.baccifera
## 1                 0              17                   4                0
## 2                 0              12                   3                0
## 3                 0              11                   2                0
## 4                 0              16                   2                0
## 5                 0              31                   6                0
## 6                 2              19                   1                0
##   Vochysia.ferruginea Xylopia.macrantha Zanthoxylum.ekmanii
## 1                   0                 1                  3
## 2                   0                 0                  4
## 3                   0                 0                  8
## 4                   0                 0                 13
## 5                   0                 0                  3
## 6                   0                 0                  1
##   Zanthoxylum.juniperinum Zanthoxylum.panamense Zanthoxylum.setulosum
## 1                       0                    2                     0
## 2                       0                    2                     0
## 3                       1                    2                     0
## 4                       1                    5                     0
## 5                       0                    5                     0
## 6                       0                    3                     0
##   Zuelania.guidonia
## 1                 0
## 2                 0
## 3                 0
## 4                 1
## 5                 0
## 6                 2
```

Calculate Shannon index. 'Margin = 1' means diversity is calculated row-wise; 'Margin = 2' means diversity is calcualted column-wise.With base = exp(1), we are esimating Shannon's index using the natural logrithm of each taxon's relative abundance using the equation; H' = -Si pi ln (Pi)

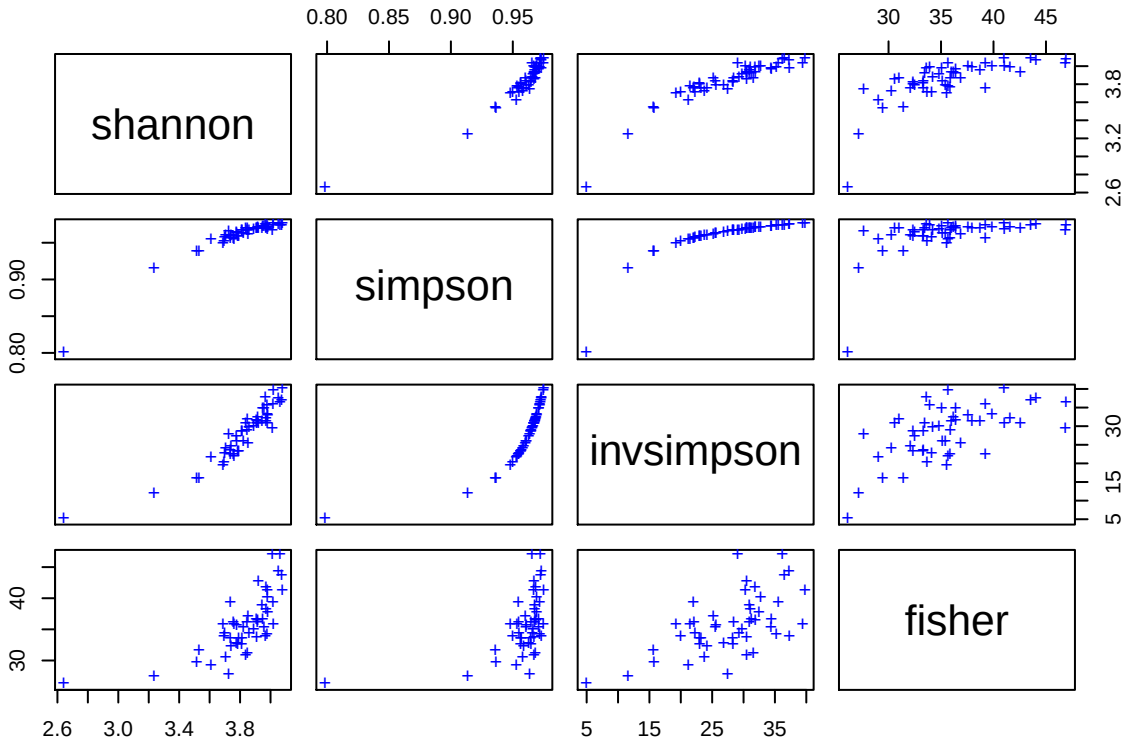
```
shannon<-diversity(BCI,index="shannon", MARGIN=1,base=exp(1))
```

Can also calculate other diversity metrics

```
simpson <- diversity(BCI, "simpson")
invsimpson <- diversity(BCI, "inv")
fisher <- fisher.alpha(BCI)
```

Let's plot

```
pairs(cbind(shannon, simpson, invsimpson, fisher), pch="+", col="blue")
```



Species richness

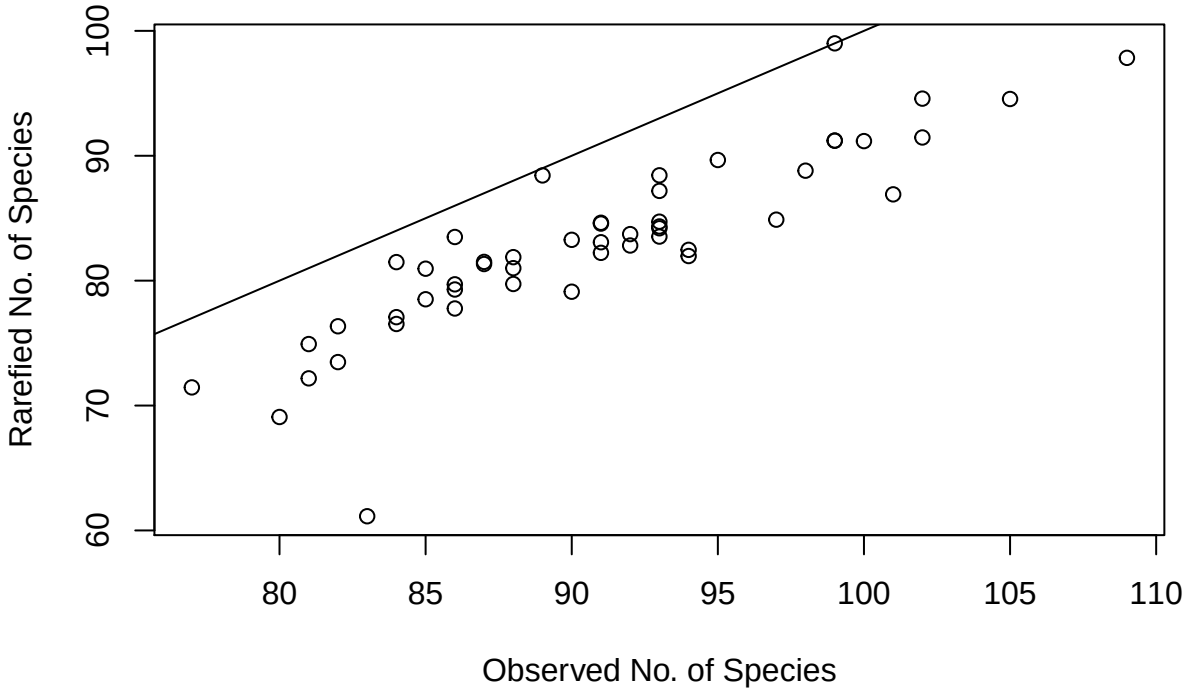
```
S <- specnumber(BCI)
```

Rarefaction

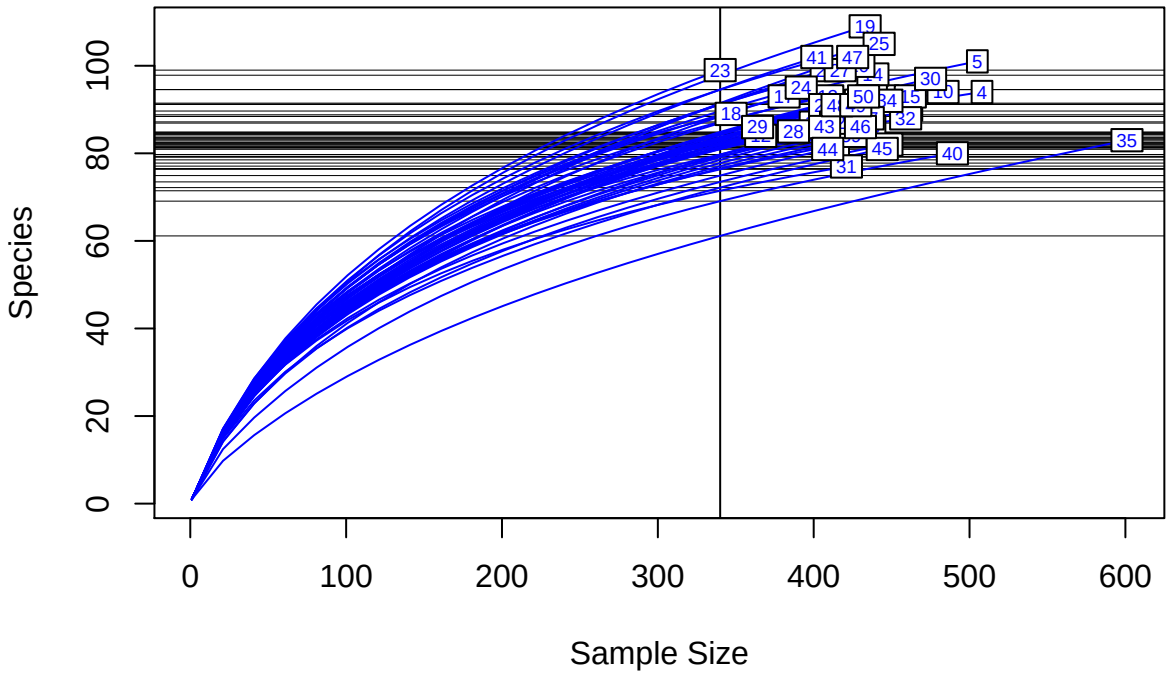
```
(raremax <- min(rowSums(BCI)))
```

```
## [1] 340
```

```
Srare <- rarefy(BCI, raremax)
plot(S, Srare, xlab = "Observed No. of Species", ylab = "Rarefied No. of Species")
abline(0, 1)
```




```
rarecurve(BCI, step = 20, sample = raremax, col = "blue", cex = 0.6)
```



http://www.jennajacobs.org/R/rarefaction.html