Indicator Species Analysis

Indicator Species:
- reflect environmental conditions
- environmental conditions, in turn, reflected in groups of sample units
- ideal indicator species is:
    - exclusively faithful to group (EXCLUSIVITY)
    - occurs in all sample units within a group (FIDELITY)

Useful because they:
- can help id species preferences
- can be used to id environmental change
- can be used to predict:
    - vegetation types
    - impacts of disturbance

Analysis based on:
1. frequency: relative frequency of species within group (FIDELITY)
2. abundance: concentration of abundance within particular groups (EXCLUSIVITY)

** therefore applies only to species data

Dufrene & Legendre (1997) method of calculating Indicator Species values:
1. assign indicator value index between a species and each group
2. identify the group with the highest association value
3. use randomization methods (permutation test) to test statistical significance of value

Two elements necessary for indicator species analysis:
1. matrix of species in ≥2 groups of sample units
2. vector of criteria used to classify groups – it can be:
    a. part of study design/treatment
    b. based on species composition
    c. based on disturbance state

r packages available:

1. indicspecies – computes different indices including IndVal (Dufrene & Legendre 1997) with an extension by De Cáceres (2010)
2. labdsv – older package which only calculates IndVal (Dufrene & Legendre 1997)
3. vegan – indpower – uses indicator power calculation of Halme et al. (2009)

Exercise adapted from De Cáceres 2013

Install and load **indicspecies** package
We will use the sample dataset wetland included in the package

load the data set (matrix of plots and species composition)
> data(wetland)

create a vector using c() - the concatenation function (join strings together) and rep() -
replicate value specified number of times ie. repeat 1 17x
> groups = c(rep(1, 17), rep(2, 14), rep(3,10))
> groups

multipatt = multi-level pattern analysis - uses Dufrene & Legendre (1997) + De Cáceres
(2010) extension
> indval = multipatt(wetland, groups, control = permControl(nperm=999))
> indval

summary of results for significant indicator species (alpha set at 0.05 automatically):
> summary(indval)

Variations to try:

divide the indval into its 2 components:

A. *specificity/probable predictive value* – probability that the site belongs to the target group i.e. if A=1 for species calpurp, then calpurp is a good indicator because it occurs only in that group (EXCLUSIVITY)

B. *fidelity/sensitivity* – probability of finding species in sites belonging to the group i.e. if B=1 for species calpurp then all sites within the group contain calpurp (ALWAYS FAITHFUL TO THE GROUP)

> summary(indval, indvalcomp=TRUE)

summary of results for all species:
> summary(indval, alpha=1)

for list of all species with occurrence in all groups (use to see which species occur in all groups
> indval$sign

Example of multipatt results from summary(indval):

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 Multilevel pattern analysis
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 Association function: IndVal.g
 Significance level (alpha): 0.05

 Total number of species: 33
 Selected number of species: 11

 Number of species associated to 1 group: 7

 Group 1  #sps.  3
       stat p.value
Ludads 0.907   0.001 ***
Orysp. 0.823   0.003 **
Psespi 0.602   0.013 *

 Group 3  #sps.  4
       stat p.value
Pancam 0.910   0.001 ***
Eupvac 0.724   0.003 **
Cynarc 0.602   0.006 **
Abemos 0.447   0.047 *

## THE ABOVE IS ACCORDING TO LEGENDRE & DUFRESNE (1997)
## BELOW IS THE RESULTS FROM THE EXTENSION ADDED BY DE CACERES (2009)

 Number of species associated to 2 groups: 4

 Group 1+2  #sps.  1
       stat p.value
Elesp. 0.741   0.003 **

 Group 2+3  #sps.  3
       stat p.value
Melcor 0.876   0.001 ***
Phynod 0.715   0.007 **
Echell 0.651   0.012 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

References

De Cáceres, M. and P. Legendre. 2009. Associations between species and groups of sites: indices and statistical inference. Ecology 90: 3566-3574.

De Cáceres, M., P. Legendre, and M. Moretti, 2010. Improving indicator species analysis by combining groups of sites. Oikos 119: 1674-1684.

De Cáceres, M. 2013. How to use the indicspecies package (ver.1.6.7). Website: http://cran.r-project.org/web/packages/indicspecies/vignettes/indicspeciesTutorial.pdf [accessed April 2, 2013].

Dufrêne, M and P. Legendre. 1997. Species assemblages and indicator species: the need for a flexible assymetrical approach. Ecological Monographs 67: 345-366.

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