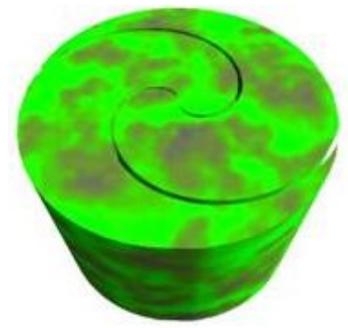# Focus program walk-through

Note: this document is intended only as an aid to using the Focus software program and has not been peer-reviewed. Please reference the original paper in BioScience by Holland, Bert and Fahrig:

Holland, J. D., Bert, D. G. and Fahrig, L. 2004. Determining the spatial scale of species' response to habitat. Bioscience 54:227-233.

We will add to this documentation as we find time. This theoretical example highlights the steps involved in using the Focus program to determine the spatial scale at which a species responds most strongly to an environmental variable. We use the example of a beetle responding to the amount of forest cover, but the predictor and response variables could be almost anything. Note that there are assumptions behind this analysis which are tested by Focus, details appear in the Bioscience paper.

One method of determining the scales at which a species responds to a landscape variable is to model the relationship between the landscape variable and the species response at a number of scales and determine where the fit of the model is best. In the example presented here the beetle's response is measured by the abundance of that species at plots centered within the areas within which the amount of forest cover is measured. The first step then is to run a regression between the amount of forest measured at one distance around the sites and the abundance of the species at these sites. From this regression we take a measure of model fit (R^2, r, or MSE).
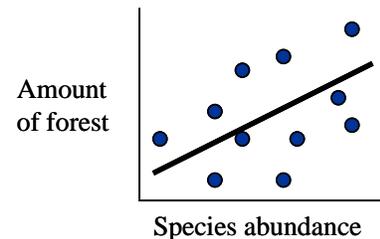
This procedure is then repeated with the amount of forest measured within several different distances (at different spatial scales). The measures of model fit resulting from the regression models at each scale are then plotted against the scale at which the regressions were run to see how the model fit changes with the scale of the habitat measurement. The scale where the model fit is best has been called the *characteristic scale* of response.
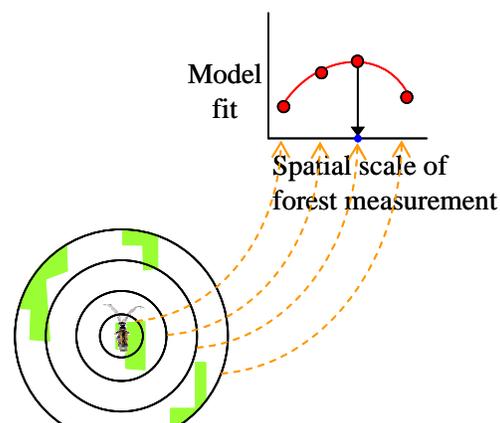
However, a practical problem that arises when conducting such multi-scale analyses is that, at large scales the landscapes may overlap with each other. This compromises statistical independence of the data
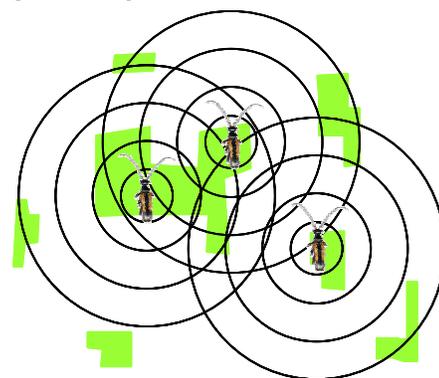
and reduces the potential range of values of the landscape structure variable(s). We developed a resampling technique and software program (Focus) to deal with this issue. Focus can also deal with constraints to point selection such as spatial autocorrelation.

Three matrices form the main input into the Focus program: a matrix of the sampling plots and the response variable values (abundances of beetles in this example), a matrix of the habitat measurements at various scales around these plots (forest cover within different distances in this example), and a symmetric matrix of the plot-to-plot distances. These are shown in matrix form with column headings in the figure.

PLOT	ABUND
101	1
102	0
103	7
104	6
105	4

PLOT	HAB 20M	HAB 40M	HAB 60M
101	0.564	0.654	0.156
102	0.654	0.267	0.627
103	0.237	0.567	0.137
104	0.578	0.268	0.167
105	0.987	0.875	0.468

DIST	101	102	103	104	105
101	0	102	466	6574	385
102	102	0	1654	657	26
103	466	1654	0	654	871
104	6574	657	654	0	327
105	385	26	871	327	0

The settings for Focus are controlled through the focusconfig.xml file; these may be changed by opening the file in a text editor such as WordPad. Upon doing so you are presented with code similar to that below:

```
<!-- This is the configuration file for the FOCUS-2.0 program. Please refer to the user guide
     for parameter settings -->
<?xml version="1.0" encoding="UTF-8"?>
<Focus>
        <Configuration>
                <Number_Of_Iterations>1000</Number_Of_Iterations>
                <Maximum_Plots_Per_Iteration>10</Maximum_Plots_Per_Iteration>
                <Report_Zero_Regressions>no</Report_Zero_Regressions>
                <DuplicateSamples>
                        <Allow>no</Allow>
                        <Retrials>100</Retrials>
                </DuplicateSamples>
                <FunctionalStability>
                        <Enable>yes</Enable>
                        <Maximum_Order>5</Maximum_Order>
                        <Percentage_Of_Runs>50</Percentage_Of_Runs>
                </FunctionalStability>
                <Statistics>yes</Statistics>
                <WritePlots>yes</WritePlots>
        </Configuration>
        <PlotSet>
                <Type>Plot-Buffer</Type>
                <InputFiles>
Plot-to-plot distances<Plot_Distances>Distance_Matrix.csv</Plot_Distances>
Species response matrix<Predictor_Variables>Predictor_Context_Variables.csv</Predictor_Variables>
Habitat at diff scales <Response_Variables>Response_Variables.csv</Response_Variables>
                </InputFiles>
                <OutputFiles>
                        <BaseName>TestRun</BaseName>
                        <TimeStamp>no</TimeStamp>
                </OutputFiles>
```

```
            <Constraints>
                    <Distance>
                            <Value>20</Value>    List of spatial scales to use in analyses
                            <Value>40</Value>
                            <Value>60</Value>
                    </Distance>
                    <Multiplier>2</Multiplier>
                    <SampleType>outside</SampleType>
            </Constraints>
        </PlotSet>
</Focus>
```

The text in blue indicates what some of the inputs are. User inputs are shown in red. Note that input files should be in csv format, and be located within the same directory as the Focus program. For more details on all the settings available and what they do please refer to the pdf User Guide. For more detailed background information please refer to the paper in BioScience by Holland, Bert and Fahrig.

The program is run from a command prompt by typing "run focus21 FocusConfigPB.xml". When Focus is run, it uses the matrices to first pick a set of points that are independent of one another based on the criteria chosen. In this example plots must have non-overlapping areas within which the forest cover was measured, e.g. they must be at least 2 times as far apart as the spatial scale at which the forest cover was measured. These independent points are then used in a regression of the abundance at the plots and the forest cover measurements around those plots. The resulting model fit parameters are recorded. This process of independent point selection and regression is then repeated however many times are specified in the focusconfig.xml file under <number of iterations>.
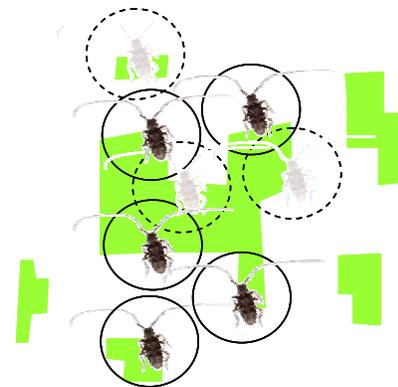
Focus repeats this process at each spatial scale, and so generates the mean and variance of regression model fit at each spatial scale. The output from Focus is 2 files. One file contains the raw data for each regression at each scale, along with a list of the individual plots chosen for each regression. In this way, Focus can be used simply to generate sets of independent plots for further analyses. The other file contains a summary of the analyses at each spatial scale. Using this file the researcher can plot the mean model fit against spatial scale to see how the relationship between the species response and the habitat changes with the spatial scale of consideration.

1000 regressions per scale