# PowerNiche 2.0 

## User's Manual

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## 1. About the PowerNiche 2.0 software $\leftarrow$

PowerNiche is an Microsoft Excel 2003 based program (compatible with version MS Excel 2007 and 2010) modeling abundance patterns of species in biological communities, using various niche division algorithms (you have to enable macros in MS Excel otherwise application is not functioning).

Copyright and distribution: The PowerNiche was created by Pavel Drozd (University of Ostrava, Department of Biology, Chittussiho 10, 71000 Ostrava, Czech Republic) and Vojtech Novotny (Institute of Entomology, Branisovska 31, CZ 37005 Ceske Budejovice, Czech Republic). It is a freeware. Any commercial use of the program is possible only with the consent of the authors. Any use of the program should be acknowledged. Suggested citation:

Drozd P. \& Novotny V., 2010: PowerNiche - Niche division models for community analysis. Version 2. Available from: http://prf.osu.cz/kbe/dokumenty/sw/PowerNiche/PowerNichee.xls.

We would appreciate if you could send a reprint of any paper using the program to authors (Pavel Drozd, Vojtech Novotny) $\longleftarrow$

Registration: You can register while downloading the PowerNiche. We will notify (by e-mail) any registered users of the software about any upgrades and related software which becomes available at our www site. Please report any bugs or problems to Pavel Drozd.

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## 2. Theoretical background of the niche division algorithms $\leftrightarrows$

The distribution of species abundance in ecological communities has been modelled by various resource division models, each stipulating a particular way of partitioning a common, limiting resource among species (Tokeshi 1993, 1997). Such a resource can be schematically represented by a line of unit length, which is divided into two segments and then one of them chosen and divided again, etc. A community of $N$ species is modelled by $N-1$ such selection and division cycles; the length distribution of resulting segments is then compared with population sizes of species. Various models differ in the selection and division algorithms. The probability of segment selection can be independent of its size (Random Fraction model, Tokeshi 1993), a linear function of its size (Broken Stick model, MacArthur 1960; Tokeshi 1997), or a power function of its size (Power Fraction model, Tokeshi 1996). The point of division can be chosen at random, as in all the above mentioned models, or to produce new segments with a fixed length ratio, such as $0.75: 0.25$ in the Sequential Breakage model (Sugihara 1980).

In Tokeshi's (1996) Power Fraction model, the resource unit line is divided into two segments at random, and in each next step, one of the segments is chosen and divided at random again, until $N$ segments are obtained. The probability of an $i$-th segment being selected for division is $p_{i}=a x_{i}^{k}$, where $a$ is a constant ( $\sum a x_{i}^{k}=1$ ), $x_{i}$ is the length of the segment and $k$ is a parameter of the model. The point of division of the $i$-th segment, delimited by the $x_{\text {imin }}$ and $x_{i m a x}$ bounds on the resource unit line, is determined as $x_{i m i n}+0.5 x_{i} z$, where $z$ is a random number drawn from a uniform $(0,1)$ distribution. The length of the larger of the two segments created by this division can be any value from 0.5 to 1.0 with equal probability, so that its average length is 0.75 . The Power Fraction model with $k=0$, i.e. the sizeindependent selection probability, is identical to the Random Fraction model, while for $k=1$, the probability of selection is a linear function of the segment length and the model is identical to the Broken Stick model.

The generalised version of the model retains the segment selection procedure, but introduces a power function also to the division algorithm. The point of division of an $i$-th segment is determined as $x_{\text {imin }}+0.5 x_{i} z^{m}$, where $m$ is a parameter of the model $(m \geq 0)$. The average length of the larger segment converges to 0.5 for small and to 1.0 for large $m$ values (Fig. 1). For $m=1$, the average length is 0.75 and the model is identical to the original Tokeshi's version. For $m=0$, the division becomes deterministic as each segment is split in the middle.


Figure 1. The average length of the larger segment resulting from a division of a resource unit into two segments, using the generalised power fraction model with various values of $m$. The averages from 1000 replicates are given for each data point.

The usefulness of resource division models lies in testing and falsifying simple hypotheses on mechanisms generating patterns of abundance, particularly in situations where experiments are not possible (cf. Nee et al. 1991; Gaston \& Blackburn 1997; Gaston 1998). It should however be noted that an identical distribution can be produced by various models (see e.g. MacArthur 1960; Webb 1974; Cohen 1980; Tokeshi 1993 for interpretations of the Broken Stick model).

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## 3. How to use the PowerNiche $\leftarrow$

### 3.1 Basic manipulation: PowerNiche Toolbar.

- Create Model: First the program asks for permission to clear worksheets Results and Chart and then Model Setting window appears. After click on "Yes" button the program search for required worksheets and add them automatically if missing (the integrity is checked also during the workbook is opened by a user). To backup your previous results you can rename target worksheet (for example Chart to Chart1) before you start to create new model or stop the procedure when the program asks for permission.
- Go to worksheet: Function useful for quick movement between worksheets within workbook.
- PowerNiche Guide: Open this User's Manual.
$\leftarrow$
3.2 Model Settings: Number of replications. The size of the Excel worksheet limits the number of replications to 250 . Note that since the segment selection and division procedures (except the fixed ratio division) are probabilistic, numerous replicates ( 100 or more) are advisable in order to obtain a representative, repeatable abundance distribution. $\leftrightarrows$


### 3.3 Model Settings: Segment selection:

The Power Model: The resource unit line is divided into two segments at random, and in each next step, one of the segments is chosen and divided at random again, until $N$ segments are obtained. The probability of an $i$-th segment being selected for division is $p_{i}=a x_{i}^{k}$, where $a$ is a constant ( $\sum a x_{i}^{k}=1$ ), $x_{i}$ is the length of the segment and $k$ is the Selection Exponent, $\mathrm{k} \geq 0$. The selection probability is independent from the length of the segment for Selection Exponent $k=0$, and it is a linear function of the segment length for the Selection Exponent $k=1 . \longleftarrow$

### 3.4 Model Settings: Segment division

3.4.1 The Power Model: The point of division of the $i$-th segment, delimited by the $x_{\text {imin }}$ and $x_{i m a x}$ bounds on the resource unit line, is determined as $x_{i m i n}+0.5 x_{i} z^{m}$, where $m$ is the Division Exponent $(m \geq 0)$ and $z$ is a random number drawn from a uniform $(0,1]$ distribution. The average length of the larger segment converges to 0.5 for small and to 1.0 for large $m$ values. For the Division Exponent $m=1$, every segment length is equally probable so that the average length of the larger segment is 0.75 . For the Division Exponent $m=0$, the division becomes deterministic as each segment is split in the middle. $\leftrightarrows$
3.4.2 The Fixed Ratio: This is a deterministic division where each segment is split to produce two segments of the specified relative lengths. The relative length of the smaller segment, $s$, is entered as the parameter of the model (the length is $>0$ and $\leq 0.5$ ). $\longleftarrow$
3.4.3 Combination of various segment selection and division parameters:

| Selection <br> Exponent | Division Exponent <br> or Ratio | Model | Reference |
| :---: | :---: | :--- | :--- |
| 1 | 1 | Broken Stick | MacArthur 1960 |
| 0 | 1 | Random Fraction | Tokeshi 1993 |
| 0 | $0.25: 0.75$ | Sequential Breakage | Sugihara 1980 |

3.5 Outputs: In the Results worksheet, the relative abundance of species is reported in descending order for each replication, together with the average abundance calculated from these replicates. The average proportions of species, standard error, standard deviance, confidence intervals and minimum and maximum for given species rank are reported in the Chart worksheet where average proportions are also depicted. $\leftrightarrows$

## 4. Acknowledgements $\leftrightarrows$

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