

## Practical 1

Download a program and do the following power analyses!

1. Correlation between X and Y. You suspect that a true correlation is somewhere around  $r=0.3$ . How large sample size (i.e; how many X-Y pairs) do you need to reach a power of 80% for an alpha of 5%?
2. You are reading a paper where the authors have taken samples from sites of chemical contamination of lead (Pb) in rivers. They then correlate the strength of contamination with a measure of species diversity of aquatic macroinvertebrates across 14 sites. They find no significant correlation ( $P > 0.05$ ) and conclude that lead contamination has no effect on the macroinvertebrate fauna. What do you think about this conclusion and what is the power to detect a weak effect ( $r=0.1$ ) of lead contamination in this study?
3. You wish to test for a difference between two groups with a t-test. Preliminary data suggest that one mean is around 4 and the other is close to 5, and the standard deviation in both groups is about 2. You set alpha to 5%. How many observations do you need to do in each group (the same sample size in both groups;  $N_1=N_2$ ) to reach a power of 80%?
4. You are planning an experiment where you grow plants in three soil types. A pilot study suggests that plant biomass will be about 23, 25 and 29 in your three treatment groups. Standard deviation seems to be about 6 in all three groups. You will analyse your results with a one-way analysis of variance (ANOVA), but need to know how many replicates you need: what should the sample size be in each group (use the same sample size in all groups;  $N_1=N_2=N_3$ ) to get an approximate power of 80%?

## Further reading and software

## POWER ANALYSIS

### *THE bible of power analysis (old but still a very good basic book):*

Cohen, J. 1988. Statistical power analysis for the behavioural sciences. 2nd edition. Lawrence Erlbaum Ass., Hillsdale, NJ.

### *Other classic for a deeper understanding:*

Greenwood, J.J.D. 1993. Statistical power. *Animal behaviour* 46:1011.

Hallahan, Mark and Rosenthal, Robert. 1996. Statistical power: concepts, procedures, and applications. *Behaviour research and therapy* 34:489.

Nakagawa, S, Cuthill, IC (2007) Effect size, confidence interval and statistical significance: a practical guide for biologists. *Biological Reviews* 82:591-605.

Nicholson, M.D. and Fryer, R.J. 1992. The Statistical Power of Monitoring Programmes. *Marine pollution bulletin*. 24:146.

Thompson, C.F. and Neill, A.J. 1993. Statistical power and accepting the null hypothesis. *Animal behaviour* 46:1012.

Taylor, Barbara L. and Gerrodette, Tim. 1993. The Uses of Statistical Power in Conservation Biology: The Vaquita and Northern Spotted Owl. Conservation biology 7: 489.

**Software:**

Most software packages include some power analysis routines. These may be sufficient sometimes but are typically quite limited. I use the commercial package “PASS” for Windows. It is user friendly and very versatile: it includes power tests for a wide range of linear and non-linear tests (uni- and multivariate), as well as some non-parametric statistics. An alternative is “Power and Precision” which is also a commercial package. You can download free trial versions of both these at:

[www.ncss.com/pass.html](http://www.ncss.com/pass.html) or  
<http://www.power-analysis.com/index.html>

A very useful and free program is “G\*power 3”, which runs under both Windows and Mac OS.

R routines for power analyses are included e.g. in the “pwr” package.

Also, check <http://power.education.uconn.edu/otherwebsites.htm> for links to software and more.

**M E T A – A N A L Y S I S ( n e x t l e c t u r e . . . )**

***THE bible of meta-analysis (a must-have for those interested...):***

Cooper, H. M. and Hedges, L. V. 2009. The handbook of research synthesis (2<sup>nd</sup> ed). Russel Sage Foundation, New York.

***There is a rapidly increasing amount of publications out there. I recommend these classics, with further references given in them:***

Arnqvist, G. and Wooster, D. 1995. Meta-analysis: synthesizing research findings in ecology and evolution. Trends in Ecology and Evolution 10:236-240.

Gurevitch J, Curtis PS, Jones MH. 2001. Meta-analysis in ecology. Adv. Ecol. Res. 32:199-247.

Apart from these, you will benefit from searching “the net” (both web pages and reference databases) for the term “meta analysis” or “meta-analysis”.

**Software:**

One good software program for Meta Analysis is "MetaWin". Although a bit aged, it is highly affordable and has lots of useful basic features. You can find out more about MetaWin at their homepage, including demo downloads, and I recommend a visit:

<http://www.metawinsoft.com/>

Another is Comprehensive Meta Analysis, which you'll find at:

<http://www.meta-analysis.com/>

There are several good R packages / routines for meta analyses. See:

<http://cran.r-project.org/web/views/MetaAnalysis.html>

Simple MA:s can also be performed with any standard versatile spreadsheet program. I have used Excel and Systat myself, and both works. Excel is what I recommend, since it also requires that you know what you are doing.... There is a lot of information on the web on meta-analysis – search and see!