META-ANALYSIS GUIDELINES

A major part of your grade in BL 519 will be an original meta-analysis that you conduct based on information compiled from the scientific literature. In a typical review paper, a researcher qualitatively summarize the available literature on a particular topic, noting similarities and important differences in results among different studies. A meta-analysis is basically a quantitative review paper. In a meta-analysis, the researcher extracts quantitative data, usually based on a statistical analysis included in each study, to determine the effect size of a particular phenomenon across several studies.

For example, let's say you are interested in determining whether population density of threatened species is lower than densities of non-threatened species. Using a meta-analytical framework to answer that question would involve sampling the literature for studies comparing population densities of threatened and non-threatened species. Assume you were able to find 35 studies that used a t-test to compare population densities between threatened and non-threatened species. For your meta-analysis, you would extract the value of the t-test in each study and the sample size the t-test was based on. You would then convert each t-score to an estimate of effect size using a standard conversion we will talk more about later, weighting each effects size by its sample size so that effects based on more observations influence the overall result more than effects based on few observations. You can then calculate the mean weighted effect size across all studies. If the 95% confidence interval of the mean effect size does not include 0, that indicates that there truly was a difference in effect sizes between factor levels (in this case, population densities of threatened and non-threatened species), whereas if the confidence interval around the mean effect size includes 0, there is probably not a difference in population sizes between threatened and non-threatened species.

The three major elements of a meta-analysis are therefore:

1. A well-formulated, directional research question
2. An unbiased sample of the literature on a particular topic
3. Data from the literature that can be converted to an effect size metric, including means, standard errors, and/or sample sizes

Research question

You want to identify a research question that is of interest to you, and has been sufficiently investigated in the literature that you will be able to find several studies on your topic. For review papers, your topic can be pretty general: 'Societal attitudes towards biodiversity in megadiverse countries', 'What makes a species rare?', 'The threat of climate change for endangered plants' For a meta-analysis, it is best if your question is directional: 'Are coastal plants with low salt tolerance at greater risk for negative effects of sea level rise than species with high salt tolerance?' is better than 'Do coastal plants vary in salinity tolerance?'.

Although the meta-analysis framework is pretty generalizeable, you want to think about questions that would be analyzed using a t-test, an simple F-test (analysis of variance) or a correlation coefficient. Papers that use complex statistics for their analysis do not lend themselves to meta-analysis, unless the raw data are included so that you can calculate simple statistics yourself. In order for a study to be included in your analysei, you need to have information on some combination of the test statistic, sample sizes, mean differences, and variance. You will probably find that many studies include some but not all of the meta-data you need for your analysis, meaning that those studies cannot be included. You will probably also find that some studies include multiple factors in a single analysis (i.e., a two-or three-way analysis of variance or multiple regression model). Because the values of one factor will influence the values of the other factors in a multi-factor analysis, those results cannot be included in your meta-analysis. As you are thinking about your question, take a look at papers from the literature to get a sense of how they conduct their analyses. Make sure that you formulate a question that is answerable given the analyses available in the literature.

Literature survey

Students are required to use a standardized protocol for surveying the literature related to their topic. You may chose to survey articles from a particular subset of journals (i.e., five of the leading international ecology journals), or from a literature database (i.e., all articles matching a group of keywords published between 2000—2015). The protocol you use is less important than the fact that it is standardized and replicable—as an author you do not want to make yourself vulnerable to the criticism that your survey of the literature is biased, so your survey protocol needs to be transparent. You should aim for inclusion of at least 10 studies in your database. Of course, more data is better, but because we have limited time over the course of the semester, it may not be possible to survey the entire literature on a particular topic. If your question touches on a data-rich topic, you may have to limit yourself to a subset of studies with relevant data. For the purposes of this paper, that is fine, as long as you can justify your procedure for sub-sampling the literature.

Although it may be possible that you find many more relevant studies than you could possibly include in your analysis, it is likely that at least some people will find that there are not enough published studies with extractable data. Start your literature survey early, get a sense of the different ways people do analyses, and try to think of a way to ask an interesting question that takes advantage of the available data, without spending weeks and weeks scouring the internet to determine that no one analyzes their data using standard statistics that can be converted to an effect size.

Writing your paper

Although there is some variability in how meta-analyses are structured, your meta-analysis will follow the format of a traditional scientific paper. Your methods section will describe the protocol you used for surveying the literature, and criteria used

to include selected studies. You will also describe the quantitative approach your meta-analysis will take. The results will describe your new analysis of data extracted from previously-published studies. You will use the software Meta-Win to conduct your analysis. I will work with you to conduct your analysis, and will provide additional information from the Meta-Win user's guide at a later date.

Your meta-analysis should not exceed 7500 words from the first word of the abstract to the last word of the literature cited. Unless noted otherwise in this document, follow the style guide and instructions for authors at the journal Conservation Biology: Conservation Biology Instructions for Authors.