Appendix A

A WORKSHEET FOR AUTHORSHIP OF SCIENTIFIC ARTICLES

Inclusion as an author in a scientific publication is important to many ecologists for reasons of prestige and advancement. Publications are a key factor in deciding on promotions for many ecologists at universities (Jackson and Prados, 1983; Croll, 1984). The order of listed authors on a paper is assumed to be an indication of the relative contribution of each of the included authors.

Day (1983:15-19), Croll (1984), Kennedy (1985), and Jackson (1988) reviewed contemporary difficulties with decision-making in assigning authorship. Dickson et al. (1978) proposed guidelines for determining inclusion and ranking in authorship of a scientific publication. They divided research investigations into 5 areas: conception (including funding), design, data collection, data analysis, and manuscript preparation, and recommended that authors need to make, at a minimum, a significant contribution in manuscript preparation and in at least 1 other area. Authorship order was determined by a ranking of the number of areas in which significant contributions were made.

This paper details a method for assisting in 1) deciding who is to be listed as an author on a paper, and 2) the ordinal ranking of authors listed on a paper. Of course, the best procedure for dealing with potential problems in assigning authorship is to deal with the issue at the beginning of a study. However, even preassigned roles can have complications, especially when personnel on a project change, or when responsibilities are transferred. In addition, people often underestimate the inputs required, especially time, for the various contributions, making initial agreements, in retrospect, seem unfair. The trend toward multi-authored papers may indicate how research is becoming increasingly interdisciplinary. In these situations a method for defining authorship roles becomes useful. This simple technique should be a useful decision-making aid, especially for projects with many researchers involved.

A general framework for a decision-making worksheet, with an example, is given in Table 1. For each of the 5 parts of the research investigation (as defined by Dickson et al., 1978), the relative contribution of each participant is assessed. For each part, total contributions should equal 100 percent. When all contributions have been assigned, row values are added, resulting in a "score" of between 1 and 500. The relative contribution of all participants can then be assessed, and a natural break between subsets of scores on the lower end of contributions can be used as a cut off to delineate inclusion as an author. Scores can then be ranked for order of authorship.

This technique has a number of assumptions. First, it assumes that each of the 5 parts of a research investigation are weighted equally. In some situations, this may not be the case. For example, a study may require minimal funding, the infrastructure of a principal investigator's laboratory may be essential to a successful project, or the data set may be collected over several years. This situation is easily dealt with by weighting the unbalanced part with a multiplier. For example, all values in the "data collection" column can be multiplied by 1.2, if data collection is judged to have been 20 percent more important than the other areas.

Secondly, this technique assumes that all contributions can be judged fairly and accurately. This may not always be the case; indeed, it may be that this technique would only be necessary for papers where it is difficult to assess contributions. Two points are suggested for resolving this. First, it must be recognized that each contribution score is usually an estimate, and, as such, has some corresponding error associated with it. Therefore, the difference of only a few points between participant's scores is probably not sufficient to rate relative contributions, and other methods must be utilized to determine authorship

ranking (perhaps even a flip of a coin). Secondly, a consensus-type survey system, such as the Delphi system (Schuster et al., 1985), may be useful as an in-house tool for resolving difficult authorship assignment problems, although it is recognized that assigning authorship is rarely a democratic process.

How are contributions assessed? One method that could be used is the actual time (hours, days, years) put into each of the 5 parts of the research investigation. A key problem here is the importance of experience. For example, how would you rate a 2-hour contribution to a project's design from a person with 30 years of experience with a 2 hour contribution from a person with little or no experience? Another method, admittedly subjective, is an assessment of the "importance" (relating to intellection) of contributions in each area. Again, a consensus-type survey can be helpful in arriving at an acceptable and agreeable assessment. The development of some criteria for better assessment of contributions is needed. Time should be minimized while intellectual contribution should be maximized, yet it is easy to visualize a project in which time is a real measure of effort.

Finally, there is a situation, which involves teams of workers involved in 1 of the 5 parts. A realistic example would be having many workers assisting in data collection. Although the team's contribution may be large (perhaps 100 percent of the data collection), the relative contribution of each team member is small. The "points" given to this team may then be assigned to the team coordinator or leader. There is some question whether a "technician" should ever be a coauthor, especially if his or her sole responsibility is data collection or data collection and analysis, when the analysis is limited to performing perfunctory operations rather than interpretation (Dickson et al., 1978).

It must be repeated that this system for determining authorship of scientific articles should not replace authors consulting with each other. However, it should be useful in delineating relative individual contributions when there are many, and it can help project coordinators or senior authors identify personnel whom have contributed in a significant way to a study's conclusion. Authorship is a symbol that means taking responsibility for the contents of the paper (Jackson, 1988). If the responsibility is there, inclusion as a coauthor is appropriate. This worksheet should be helpful in defining this responsibility.

Acknowledgments

For helpful comments on this essay, I thank C. Shugart, W. Howard, J. Aloi, R. Case, T. Tornasi, D. Anderson, R. Johnson, J. Tully, P. Moyle, and T. Salmon.

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Table 1. Format and example of a worksheet for determining the relative contributions of participants in a research project. Values listed are percent relative contributions. In this example, a natural cut off for authorship status would be between Technicians C and D. Authorship ranking should be Leader A, Leader B, and Technician C. The number in parenthesis is a multiplier (see text for details).

INVESTIGATOR	CONCEPTION (1.0)	DESIGN (1.0)	DATA COLLECTION (1.0)	DATA ANALYSIS (1.0)	WRITING (1.0)	TOTAL
Leader A	50	90	0	70	40	250
Leader B	50	10	20	0	30	110
Technician C	0	0	40	30	30	100
Technician D	0	0	40	0	0	40
Column totals	100	100	100	100	100	500

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